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THE

FOSSIL INSECTS OF NORTH AMERICA,

With Notes on Some European Species.

BY

SAMUEL H. SCUDDER.

IN TWO VOLUMES.

VOL. I.

THE PRETERTIARY INSECTS.

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INTRODUCTION.

THE ESSAYS contained in the first volume of the present work have no logical connection except that they cover nearly the whole of a single limited field whose scope is indicated by the title. They were written and printed at different times during the last twenty-five years, and are here issued exactly as first printed; indeed, the sheets were struck off from time to time from the same type without alteration in the body of the text.

It is evident, therefore, that as the subject has greatly developed within the past quarter of a century, and the writer's views have undergone some modification during that development, the different essays are not so consistent when compared with one another as would be expected in a volume the text of which was published for the first time. It has been thought best, however, not to rob the essays of such historic value as they possess, since they constitute almost the entire body of American literature upon the older fossil insects. Such few papers (or at least the important ones) as have been contributed to the subject by other American writers are indicated in the bibliographical note which forms the concluding essay, where also the writer's other essays (mostly excerpts or abstracts of these memoirs) are noted.

In like manner the second volume contains substantially all that has ever been written upon the later fossil insects of America, where (excepting a single paper by Dr. G. H. Horn) the author has been the sole worker. The volume is the same as that just issued in the Reports of the Hayden Survey, with the simple addition of the preliminary title to connect it with the present series; and it includes, besides the new material, all the descriptions of tertiary American insects which had been previously published, occasionally with additions and corrections to

the same, excepting a few Hymenoptera, Diptera, and Coleoptera — in all eight species — that have been described from Florissant (by the author), and the few butterflies from Florissant (seven species) which appeared in his paper on the same in the 8th Annual Report of the United States Geological Survey.

Thus the two volumes, of which only one hundred copies are published in this connected form, not only contain, with the slight exceptions just noted, a description of all the species of fossil insects (hexapods, arachnids, and myriapods) of all American strata so far as known, but practically include the entire body of literature upon this topic. At the same time descriptions of a few European insects and critical remarks on others will be found herein.

SAMUEL H. SCUDDER.

CAMBRIDGE, MASS., September, 1890.

An Inquiry into the Zoölogical Relations of the first discovered traces of Fossil Neuropterous Insects in North America; with Remarks on the difference of structure on the Wings of living Neuroptera. *By* SAMUEL H. SCUDDER.

Read before the Boston Society of Natural History, January 18, 1865.

IN the January number of Silliman's "American Journal of Science" for 1864, (vol. XXXVII., page 34,) Prof. J. D. Dana announced the discovery for the first time in North America of the fossil remains of Neuropterous insects. They were found in flattened iron-stone concretions, which occurred in the carboniferous beds at Morris, Illinois, in company with various coal-plants and amphipod crustaceans. Two specimens only had fallen under his observation, which, in the Journal referred to, in an article entitled "On Fossil Insects from the Carboniferous Formation in Illinois," he has figured upon wood and briefly described under the names of *Miamia Bronsoni*, and *Hemeristia occidentalis*, the former after the name of the original discoverer of these important remains.

Through the repeated courtesy of Professor Dana, I have been permitted as long an examination as I desired of these interesting fossils, the results of which, and the comparisons I have incidentally instituted with allied groups of living insects,[1] I have now the honor to lay before the Society.

The specimens imbedded in these stones exhibit the insects in the natural attitude of repose, which, as in many other Neuroptera, is with the wings overlapping one another above the abdomen; in those Neuroptera which close their wings in this manner the right upper wing overlaps the left upper wing (or the left overlaps the right), while that again overlaps the right under wing, and this the left under wing; the result is that in certain places we have actually in a cross-section four thicknesses of wing with their accompanying nervures, which last, if of sufficient thickness and strength to give an impression through these four thicknesses, when compressed between layers of mud, would in a case like that of *Hemeristia*, where the cross-veins are quite heavy and numerous, present an almost inextricable network of veins, and render it a very difficult task to determine the neuration of any one of them. In *Miamia* the nervures are feeble, though the wing-tissue is apparently correspondingly delicate; and the wings not overlapping one another so completely as in *Hemeristia*, it is not so difficult a task to determine to which wing different nervures belong; yet were it not for the general similarity of the neuration in the upper and under wings in this sub-order, it would even here be a perplexing matter. In *Miamia* the abdomen is preserved, and the nervures crossing it leave no room for doubt that the insect is viewed from above; but in the specimen of *Hemeristia* we have the additional disadvantage that we cannot tell which surface we view otherwise than by the structure and relations of the wings themselves, which besides are but fragmentary, and exhibit in continuity but a small portion of the outer margin of a single wing and the inner border of none at all, the base and apex also being absent. We have then in *Hemeristia* — given the central portion only of four wings, completely overlapping one another, unusually charged with cross-veins reuniting the branches in every part, with no external means of deciding whether the upper or under surface is presented to the eye, to determine what is the exact structure of each wing.

[1] I would here express my obligations to my friend Mr. P. R. Uhler, for the kindness with which he has permitted me to use freely his extensive and varied collection of Neuroptera, containing many forms otherwise quite unknown to me.

Looking at the right side as being in this case more complete, and following the course of the vein which appears at the margin next the base, we see that at a little distance out it sends forth a prominent branch which has a peculiar curve. Now as we know that among Neuroptera neither the *vena marginalis*[1] or *mediastina* sends off branches in this way, we necessarily conclude that this cannot be either of those veins; and as it is quite what we might expect in the *v. scapularis* and is just so important a vein as that is, and as at one side we find two veins outside of this running parallel to one another and to this, closely connected by and frequently charged with cross-veins, which in this part of the wing is often characteristic of the *v. marginalis* and *mediastina*, we conclude that these three veins belong to one and the same wing, and are those of the outer margin. Glancing at the opposite side we see the same peculiar curved vein, which here also is quite prominent, though there are no veins outside of it, and we naturally conclude that this belongs to the corresponding wing on the other side, the outer veins of which have been destroyed. We may notice next that on the right side between the peculiar curved branch and the vein from which it springs there lies a vein running midway between the two and apparently connected with either by frequent cross-veins, which being quite an anomalous feature among Neuroptera, if our previous views were right, excites our suspicions; but knowing that it would be quite as great an anomaly were there to be four parallel veins along the costal border thickly beset with cross-veins and similar in every respect, we look more closely to see if these may not belong to another wing, either above or below that to which the curved branch belongs. We notice, in confirmation of this supposition, that on the left side this dividing vein does not run midway, but considerably at one side; and observing the right side more carefully, we see that the cross-veins between the *v. scapularis* and its branch override the vein which runs midway between these two, which has also itself separate and less distinct cross-veins, connecting it with a vein which must be directly beneath the *v. scapularis;* and we therefore conclude, that the space thus covered by these less prominent cross-veins must be either the *area marginalis* or *scapularis* of the wing lying beneath; to determine which of these it is, we look for the homologue of the peculiar curved branch and find it taking its rise from this vein at a point similar in position to what we found in the wing above, and less conspicuous than there, not only as it naturally would be from lying beneath but proportionally less so, as is also the *v. scapularis* of the lower, as compared with that of the upper, wing. The area referred to is then the *area scapularis*, corresponding to the inner of the two narrow ones which lie outside the *v. scapularis* of the wing above. Now, as in Neuroptera, not to speak of other insects, the anterior half of the wing is more specialized, and contains stronger veins in the anterior wing than the corresponding portion of the posterior wing, which in its turn is generally more specialized in its posterior half, we conclude from the prominence of the *v. scapularis*, and its branch and cross-nervures in the wing which lie above, that they belong to the anterior wing, and that we view the insect from above. In very strong confirmation of this view is the fact that the *v. scapularis* of the wing above lies outside of, and yet parallel to, the *v. scapularis* of the wing below, proving, beyond a doubt, that the upper is the anterior wing; for the *v. scapularis* of the posterior wing could not lie outside of that of the anterior in any part of its course without crossing it or at least being divergent from it.

Pursuing, then, the same method of inquiry in regard to the other principal veins,

[1] See note 3 on p. 3, where these names are explained.

we discover that those of the right anterior wing cut across the principal veins on the left side which correspond to those of the right anterior wing, and therefore that the right wing overlaps the left. The position of each of the wings being then satisfactorily made out, it requires only patient examination and studied comparisons to determine of every one of the principal veins, or even detached [1] branches and cross-veins, to which of the four wings it belongs; [2] and being able thus to delineate the remnants of each of the four wings, and making up from one, so far as is proper, the deficiencies of another, and carrying our point somewhat farther into what is partly conjectural, but guided principally by our knowledge of the relations of this insect to the Neuroptera in general, we are able to reconstruct, more or less accurately, the complete structure of all the wings of this insect, as partially figured in our plate.

But this is only one step; it is indeed but the starting-point. We have now merely a basis, but a firm one, upon which to stand in making our most essential inquiry as to the relation of these ancient types to the other members of the sub-order to which we saw at first they were allied. We need to investigate something of their more intimate relationship, and to know how much kinship these forms, which flitted through the oozy marshes of the carboniferous forests, had with the living realities of our own day.

To determine this point we have in the Hemeristia only the wings to guide us (except a fragment of a leg which is here of but little value), and must therefore inquire whether the different families of Neuroptera have anything in the structure of these parts which shall enable us by their aid alone to distinguish them from one another, and to determine of any wing-form presented to our eye, to which of these groups it belongs. If we can do so, we can ask of course, in reference to the fragments in question, whether they belong to any one of the hitherto described family groups, and to which,—or whether they must form another akin to them, but belonging to the same sub-order of Neuroptera. Inquiries made with a view to determine this point have convinced me that this is quite possible, and I have therefore embodied the results of my inquiry in the following statement of the distinction in wing-neuration among the families of Neuroptera.[3]

Termitina.

The *v. marginalis* and *mediastina* run parallel to the very tip of the wing and in close conjunction, apparently with no connection between them; the *v. scapularis* also runs parallel to the *v. mediastina*, though a little more distant from it, and is sometimes connected with it irregularly by many cross-veins, directed from the *v. scapularis* upwards and outwards; generally it forks beyond the middle though sometimes close to the base. The *v. externo media*

[1] Detached by the incompleteness of preservation, for there appear to be none independent.

[2] It was only at the very last moment of examination that I discovered also the remnants of the *v. marginalis* and *mediastina* separated from the basal portion of the right anterior wing, but otherwise unbroken, lying entirely removed from the wing; and what is rather remarkable, an exactly similar fragment of the left anterior wing also entirely detached and lying at right angles to it; at the outer extremities of the first we can see faint indications of fragments of a femur and tibai at their union, which correspond pretty well, so far as can be determined, with what we find in Miamia.

[3] I have made use here of the terminology employed by Heer, in his memoirs on the fossil insects of Œningen, etc., as being more true than any other known to me, though I am not quite sure that the names are fitly chosen, to suit the homologies of wings of insects in general. He enumerates six under the following names: the first, counting from the upper border, the *vena marginalis;* second, *vena mediastina;* third, *vena scapularis;* fourth, *vena externo-media;* fifth, *vena interno-media;* sixth, *vena analis.* The spaces between the margin and the *vena marginalis* he denominates *area extra-marginalis;* that between the first and second veins, *area marginalis;* between the second and third, *area scapularis;* between the third and fourth, *area externo-media;* between the fourth and fifth, *area interno-media;* between the fifth and sixth, *area analis;* and that between the *vena analis* and the hind-border the *area externo-analis.*

is as distant from the *v. scapularis* as that is from the *v. mediastina*, and runs parallel to it, sending out many branches downwards and outwards, which fork indefinitely, the forks being never united by cross-veins; these fill up the remainder of the wing. The *area externo-media* is occupied by an independent vein, which is connected with the veins on either side by irregular cross-veins; both wings are alike. This is substantially the same account as is given of them by Heer, only that he considers what I have called the *v. mediastina* as the *scapularis*, the *v. scapularis* as the *externo-media*, and the *v. externo-media* as the *interno-media*, in which he may be correct.

Embidina.

In the *Embidina* the *v. marginalis* forms the anterior margin. The *v. mediastina* runs parallel and near to it till quite near the tip, when it is deflected downward and terminates at the *v. scapularis*, which in like manner, running parallel to the *v. mediastina*, turns abruptly downwards just at or beyond where the *v. mediastina* strikes it, and strikes the upper branch of the *v. externo-media*. The *v. externo-media* forks at a distance of one third or more from its origin to the tip of the wing, the upper branch running parallel to the *v. scapularis* till it strikes it, and then continues on in the same course to the tip; the lower fork is generally dichotomous. The *v. interno-media* is a simple vein running in quite a direct course to the margin; the *v. analis* is sometimes forked at the base, in which case the lower branch forms the hind margin of the wing, and the upper is generally simple and straight; cross-veins, very few in number, connect the *v. externo-media* with the *interno-media*, the branches of the *v. externo-media* with one another, the *v. externo-media* with the *scapularis*, and are found in the *area marginalis*.

Psocina.

Vena marginalis continuous; *v. mediastina* in the upper wing broken, in the under wing reaching the *v. marginalis*, a short distance from the base; *v. scapularis* occupying the greater part of the wing, being the only forked vein in the wing; near the base it sends out a branch abruptly downwards, which immediately turns and runs parallel to the main stem; the main stem, running in a straight course, reaches the margin beyond the middle, then deflects from it, and either strikes one of the branches of the other portion of the vein, or just before reaching it again turns abruptly upwards and strikes the margin; the main branch, running parallel to the main stem, sends out a branch at a wide angle just before the middle of the wing, which running in a straight line strikes the lower margin near the middle. Just below where the main stem reaches the upper margin, the main branch sends out another branch sub-parallel to the first, but sinuous, from which more than half way to the margin a widely spreading fork proceeds, the upper branch again and again forking widely. The main branch just beyond the origin of this second branch is itself deflected suddenly and sinuously downwards, running sub-parallel to the upper forks of the second branch, till it reaches the margin at the apex of the wing, but from the middle of its downward curve sending off a branch at right angles which forks and fills the space between the termination of the main stem and the main branch of this *v. scapularis*; at the middle of the wing a stout cross-vein unites the main branch and stem, and this is the only cross-vein in the wing. The *v. externo-media*, curving slightly with a convexity toward the apex of the wing, strikes the lower margin just behind the first branch of the main branch of the previous vein. The *v. interno-media* is but little separated from the *v. analis*, which simply forms

the lower margin of the wing. In the under wing the variation is so great from this that the main branch of the *v. scapularis* separates as a widely branching fork from the main stem some little distance from the base, and continues straight on to the margin as the first branch did in the upper wing, the main branch being then a fork from this straight one, and branching as the main one did in the upper wing, except that it wants altogether the second branch.

Perlina.

The *v. mediastina* runs parallel and pretty near to the *v. marginalis* until somewhat beyond the middle of the wing, when it turns suddenly at right angles and strikes the *v. scapularis*, which has been running nearly parallel to it, though at a less distance from it, than the *v. marginalis*. The *v. scapularis* continues on parallel to the *v. marginalis*, and runs into it a little before it reaches the tip of the wing. The *area marginalis* is traversed by frequent cross-veins; the *area scapularis* has none. The *v. scapularis* gives off a branch generally half way between the base and where the *v. mediastina* strikes it, which running sub-parallel to the main stem terminates at about the tip of the wing, crossed at some point in its course by another vein from the *v. scapularis* which generally (exc. *Tæniopterix*, etc.) continues on and connects with the upper branch of the *v. externo-media;* the branch of the *v. scapularis* then divides into many branches, which are sometimes simple, sometimes again forked, and sometimes have, in connection with the branches of the *v. externo-media*, recurrent forks.[1] The *v. externo-media* runs in very close proximity to the *v. scapularis* a little distance, and then runs parallel to the branch, until it approaches the cross-vein from the *v. scapularis*, when it forks, the forks sometimes again reforking. The *v. interno-media* has a very indistinct attachment at the base, being seen only from the under side, — is distant from the *v. externo-media*, — has a considerable curve at its commencement, and very soon forks, the upper fork running distant from, but nearly parallel to, the *v. externo-media*, gradually separating from it until near the forking of the latter, when it curves towards it and unites to its lower branch; it sends off rather distant cross-veins to its own lower branch, and beyond emits many branches to the margin. The *area interno-media* is traversed sparingly by cross-veins, sometimes in the fore wing only. The lower branch of the *v. interno-media* is simple, and diverges from the upper branch as that from the *v. externo-media*. The *v. analis* is stout and forks at its origin; the space between the forks is enclosed near to the base by a thick cross-vein which extends to the internal margin, and from mid-way between the forks sends out a branch which runs between them, any or all of which branches and forks may branch again, which they do to considerable extent in the hind wing, where also there are more branches from the cross-veins.

Ephemerina.

Fore Wing. The *v. mediastina* runs near, and parallel to, the *v. marginalis*, extending to the tip of the wing. The *v. scapularis* bears the same relation to the *v. mediastina*. The *v. externo-media* runs parallel to the *v. scapularis* for a short distance, and is at the same distance from it as that is from the *v. mediastina;* close to the base it sends out a branch, which forks when it has reached two thirds of the distance to the margin, the lower branch striking the outer margin at about the middle; at less than one third the distance to the tip of the wing the vein forks, the upper fork remaining parallel to the *v. scapularis*, while

[1] But in *Capnia* we have a very remarkable difference in that the main branch of the *v. scapularis* has its origin beyond the cross-vein from the *v. scapularis* to the *v. externo-media*.

the lower branch diverges rather widely from it, the space between being divided into equal distances by several independent veins. The *v. interno-media* starts from the same point as the former, and is simple. The *v. analis* is widely separated at the base from the previous, is much curved, first upwards and then downwards, and sends out several branches which curve as they are directed towards the margin. The veins and their branches are traversed everywhere by rather frequent cross-veins, but the wing is nowhere reticulated except slightly around the margin.

Hind Wing. Either the *v. mediastina* or *scapularis* is wanting, very probably the latter, as the *area externo-media* is very wide. The branching of the *v. externo-media* is nearer the base than in the fore wing; the *v. interno-media* is apparently wanting, and the *v. analis* is more uniformly curved.

Odonata.

Quite a characteristic feature of this group is that the *v. marginalis* extends but half way along the margin, and terminates abruptly; and that the *v. mediastina* runs nearly parallel to it, with a distinct space between them; when it reaches the point where the *v. marginalis* terminates it turns abruptly upwards, forming the "*nodus*," and protects the rest of the margin. The *v. scapularis* runs parallel to the *v. mediastina* as far as the nodus, is there connected by a strong cross-vein to the *v. mediastina*, and then continues on in a direct line to the tip of the wing. At a short distance from the origin this vein sends down a short abrupt branch, which meets a similar branch directed upwards from the *v. externo-media;* from the cross-vein thus formed, two veins take their rise; the upper I consider to belong to the *v. scapularis*, and to be properly a continuation of the short abrupt branch; it continues a short distance either parallel to the *v. scapularis* or adjacent to it (as in some Agrionina), and then branches; it generally branches twice before reaching the nodus, and once at or just beyond that point, with which it is connected by a continuation of the strong cross-vein before mentioned.[1] The *v. externo-media* runs quite directly to the margin, curving downwards more or less at the outer half, and running nearly parallel to the lowest branch of the *v. scapularis;* it sends upwards the short abrupt branch mentioned to meet that of the *v. scapularis*, which turns abruptly outwards at right angles again, sometimes joining the vein again a short distance on, sometimes continuing freely to the margin. The intricacies of the neuration are such that the *v. interno-media* can be traced definitely but a short distance, to a point below the cross-vein, uniting the *v. scapularis* and *externo-media;* here it sometimes forks, sometimes continues on single but contorted, and sometimes seems to stop altogether. The *v. analis* is frequently if not generally confluent with the preceding for a short distance, then diverges and forms the lower border of the wing. The *areæ marginalis, mediastina, scapularis* and *interno-media*, are traversed by numerous cross-veins; the *area externo-media* is free from them as far as the cross-vein; beyond this they are present; the spaces enclosed by the branches of the *v. scapularis*, and all the wing below the upper branch of the *v. externo-media*, are reticulated. That the space between what I have here considered as the lower branch of the *v. scapularis* and the upper branch of the *v. externo-media*, has cross-veins and no reticulations, except in a few cases close to the margin *(Æschnidæ)* is one reason for my conclusion concerning the meaning of the cross-vein and its branches.

Sialina.

The *v. mediastina* starts at considerable distance from the *v. marginalis*, approaching it

[1] In *Lestes*, however, it is somewhat different; it sends out a branch once before the nodus and once beyond.

gradually till it is in close proximity, when it terminates near the tip of the wing by striking the *v. scapularis*; this last runs close alongside of the *v. mediastina* and very nearly parallel to it, striking the *v. marginalis* at just about the tip of the wing. At about one quarter of the distance from its origin it sends forth a branch downwards and outwards, which having passed a distance about equal to that of the undivided parent stem, forks, the upper branch again forking, the upper branch of this fork again forking, and so on, the upper branches in their course gradually approaching nearer to the main stem, connected to it by a single cross-vein or two, and finally reaching the tip of the wing in close proximity; the various lower branches are connected together by a few scattered cross-veins, as are those of the rest of the wing. The *v. externo-media* starting and continuing in close proximity to the *v. scapularis*, diverges from it at about half the distance to the branch of the former; from here it runs parallel to the branch of the *v. scapularis* and not far from the middle of its whole course, and just below the divarication of the *v. scapularis*, forks, the upper fork sometimes forking again. The *v. interno-media* forks from its very origin, the upper fork turning sharply upwards against the *v. externo-media*. One examining these veins without great care would consider the former a branch of the latter, were it not that the branching does not occur in the lower wing of Chauliodes until a very little past the origin; beyond its collision with the *v. externo-media* the upper branch runs sub-parallel with the lower branch of that vein, and sends out branches from the under side more or less. The under branch, with a slight curve, runs directly to the margin, forking once a little before reaching it. The *v. analis* forks at its origin, the forks being connected close to the base by a cross-vein; each of the forks again divaricates, and their proximate forks are connected by a cross-vein.

Hemerobina.

This family includes a greater variety of forms than any other, even after we have excluded from it many of the lesser families with which they are erroneously associated (as I believe) by Hagen. To comprise the genera Ascalaphus, Nemoptera, Acanthaclisis, Polystoechotes, Chrysopa, Sisyra, and Drepanopteryx in one group and show a uniformity of character in the venation of the wings as great as they exhibit in other features, which shall also distinguish them from the other families, and especially from some of those included within it by Hagen, is certainly more difficult than the definition of many other of the families, including as it does the more aberrant forms of the sub-order. The lower wing of Polystoechotes is perhaps as fair an example as any of the family.

The *v. marginalis* is continuous and regular, except in Drepanopteryx, etc., where it is very much curved abruptly forward next the base. The *v. mediastina* is straight, and except where the *v. marginalis* is swollen, as in Drepanopteryx and Chrysopa, is parallel to the *v. marginalis*, terminating near the tip of the wing by striking either the *v. marginalis* (e. g. Chrysopa, Drepanopteryx,) or the *v. scapularis* (e. g. Acanthaclisis, Polystoechotes, Nemoptera, Ascalaphus, Sisyra). The *v. scapularis* runs parallel to the *v. mediastina* most of the way from the base to the tip, where it terminates, generally just at the tip. It sends down a branch, either quite near the base (Polystoechotes, Drepanopteryx, Sisyra), or at about one third the distance from the base (Ascalaphus, Acanthaclisis, Chrysopa), or even so far as the middle of the wing (Nemoptera), which strikes the border so as to include above it seldom less than half of the wing, and often (especially Polystoechotes) much more. From near the origin of this branch it sends forth another branch parallel to the main

stem, which runs equidistant from it to the outer border, or reunites with the main stem, sending off continually branches parallel to the first-mentioned branch. These latter branches are either united by frequent or infrequent cross-bars, or they may fork to an indefinite extent, or only near the border, or the space between the first branch and its branchlet, parallel to the main nervure, may be filled with a net-work of veins. The main stem and the branch parallel to it may be united by few or many cross-veins. The *v. externo-media* may be either perfectly simple (Nemoptera, Acanthaclisis), or it may fork once from near where it leaves its close conjunction with the previous nervure, generally diverging narrowly, and have its forks continually united by cross-veins, while the spaces on either side are differently characterized, or in some other way show more or less distinction from the surrounding spaces, or it may so fork without such distinction (Drepanopteryx, Chrysopa, Polystoechotes), or it may fork farther from the base, and refork once or twice (Sisyra); at all events, it occupies quite an unimportant part, Chrysopa alone excepted. The *v. interno-media* extends generally some little distance from the base before forking, though sometimes it forks quite near to it, and generally occupies considerable space, in which the character of venation is similar in nearly every case to that seen in the space occupied by the *v. scapularis*. In Drepanopteryx, Nemoptera, Ascalaphus, and Acanthaclisis, they are especially prominent, while in Chrysopa the large extent of the *v. externo-media* seems to be balanced by the slight development of this vein, for it simply forks once, curving downwards and meeting the border. The branches proceed downwards toward the border mainly parallel to one another, and thrown off from the upper branch of the original fork, which itself runs in close proximity to the *v. externo-media*. The *v. analis* generally occupies but a small space, forking at least once, sometimes its forks uniting and from their union sending forth new forks. In one instance at least (Polystoechotes) it occupies a larger space, and forks indefinitely.

In that abnormal genus of Hemerobina, Nemoptera, where the hind wing is reduced to a long, ribbon-like appendage, the *v. externo-media* alone is wanting; all the rest are perfectly simple and parallel.

Coniopterygidæ.

In this family the venation is very simple. The *v. marginalis* (if it exists) is continuous. The *v. mediastina* is simple, parallel to *v. marginalis*, and extends to the tip of the wing. The *v. scapularis* forks near the middle of the basal half of the wing, the lower branch forking widely shortly before it reaches the lower angle, the upper continuing parallel to the *v. mediastina*, sending out a branch sub-parallel to the lower branch, which forks widely before reaching the border. The *v. externo-media* is simple, runs sub-parallel to the *v. scapularis*, and is united to it by the only cross-vein that exists in the wing, just anterior to the branching of the former. The *v. interno-media* forks at its origin, the forks continuing sub-parallel to the former. The *v. analis* exists only on the border, if at all.

Rhaphidiidæ.

The *v. marginalis* is continuous. The *v. mediastina* runs parallel to the former and strikes it in the apical half of the wing. The *v. scapularis* runs parallel also to the *v. marginalis*, and terminates at the tip of the wing. It sends off a widely diverging branch near the middle of the wing, which forks widely before it has passed half way to the margin, the upper fork

running nearly parallel to the extension of the *v. scapularis*, and is united to it by several cross-veins, while the lower one keeps on nearly the original course. The two forks are reunited afterwards by a cross-vein which runs parallel to the border, and sends off several branches to it. The *v. externo-media*, running a short distance parallel to the last, soon diverges considerably from it and immediately forks, the lower fork reaching the border at the middle, or sometimes nearer the base. The upper fork, sometimes united to the *v. scapularis* by a cross-vein, soon forks again, its two forks continuing at about equal distances from each other, from the other fork, and from the branch of the *v. scapularis*. These three forks, half way from the original branching to the border, are reunited by cross-veins, which send forth borderwards other branches, which are sometimes simple, sometimes forked and sometimes united again by cross-veins, like the original branches which send forth others to the border. In a similar way are the outer upper ones united by cross-veins to the branches of the *v. scapularis*. The branches of this vein occupy more space and are generally more prominent than those of the *v. scapularis*. The *v. interno-media* forks close to its origin, is thereafter simple, or nearly so, but may have its forks united by an occasional cross-vein to one another, or to the veins on either side. The *v. analis* is unimportant and has but a single fork.

Mantispadæ.

The *v. marginalis* is continuous, curving upwards next the base. The *v. mediastina* runs sub-parallel to it, and terminates abruptly at the outer extremity of the pterostigma, on the apical half of the anterior margin, either by a cross-vein uniting the *v. marginalis* with the *v. scapularis*, or by abruptly bending upon the latter. The *v. scapularis* runs in a straight course to the apex of the wing, parallel and in close proximity to the *v. mediastina*, so long as that continues; it sends out two parallel branches near to one another at about the middle of the basal half of the wing, from the second of which springs a branch which runs parallel to the *v. scapularis* itself to the very tip of the wing, connected with it by an occasional cross-vein, and sending out equidistant branches parallel to one another and to the first branches mentioned. They fork once next the border, just before which they are united together by cross-veins or by recurrence. They are united in a similar way to the first branches of the *v. scapularis*, which latter are also united together by a cross-vein, which is a continuation of the parallel branch of the second branch but is placed at an angle to it. The *v. externo-media* forks widely at the very base, is almost immediately united again, from which union a short branch or cross-vein connects it with the *v. scapularis* anterior to its branching, while two others widely divergent at origin run sub-parallel to the branches of the *v. scapularis*, are again united not far from the margin by a cross-vein, from which springs another branch. The *v. interno-media* is simple, and is united by single cross-veins to the veins above and below. The *v. analis* forks but once.

Panorpina.

The *v. marginalis* is continuous. The *v. mediastina* is unimportant, parallel to it, and terminates by striking it at about two thirds the distance from its origin. The *v. scapularis* runs in contiguity with the former for a short distance, then diverging a little distance forks, the upper branch running parallel to the *v. mediastina*, and at about the same distance from it, as it is from the *v. marginalis*, till it terminates by striking the *v. marginalis* a little way beyond where the *v. mediastina* strikes it, never forking except sometimes near the tip.

The lower branch forks and reforks again several times. This vein, with the two previous, occupy just about one half of the wing. The *v. externo-media* can with difficulty be distinguished from the *v. scapularis* next the base, since it runs for a short distance in very close contiguity to it, after which it diverges and runs sub-parallel to the lowermost branches of the previous veins, forking about the middle of its course, each of the forks dividing once more. The *v. interno-media*, taking its origin at a distance from the *v. externo-media*, curves directly up into close proximity to that, then diverging runs nearly parallel to it, forking once at no great distance from the base (but in Bittacus at the base), thereafter remaining simple. The *v. analis*, except where it is atrophied, as in Bittacus, forks at the base. The upper branch, curving like the *v. interno-media* and running parallel to it, remains simple. The lower branch forks again immediately, the lower fork (forming the margin) dividing once more, but with these exceptions remaining simple. All the areas, and the spaces between the branches, but especially those beyond the middle of the wing, have conspicuous but very infrequent cross-veins. There are none in the *area externo-media* previous to the forking of the *v. externo-media*.

PHRYGANINA.

The *v. marginalis* is continuous. The *v. mediastina* is straight and runs into the margin in the apical half of the wing. It is connected with the *v. marginalis* close to the base by a strong cross-vein. The *v. scapularis* branches very near the base. The upper branch is simple, and running parallel to the *v. mediastina*, reaches the margin before the apex. The lower branch branches again before the middle of the wing, the branches connected half way to the outer border by a bent cross-vein, which sends out a branch parallel to and midway between these. The *v. externo-media* bends up towards the *v. scapularis*, then diverging from it forks not far from the origin, the branches united at half their distance to the border by a cross-vein, at which point they both fork, the upper fork of the upper branch again and again forking, each time approaching the lowermost branch of the *v. scapularis*, with which the last is joined by a cross-vein, which is continuous with the forks of this vein and the cross-vein of the *v. scapularis*. The *v. interno-media* is simple, and runs parallel to the lower branch of the *v. externo-media*. It terminates at the border or at a cross-vein which unites the lower branch of the *v. externo-media* with the border. The *v. analis* forks at the base, the upper branch running parallel to the *v. interno-media*, and united near the base to the other branches, one of which forms the internal margin and the other is short and unimportant.

Since form dependent on general structure is a characteristic of families, as Agassiz has well presented it, we might have properly anticipated what we now find from this review, viz.: that distinctions of a general nature in the neuration of the wings correspond with the family divisions; for it is upon the structure of the wings of insects that their form very much depends. Especially is this true in Neuroptera, where, as much as in any other group except Lepidoptera, the form is presented most obviously in the contour of the wings. No systematists, however, have used these characters in the Neuroptera to any extent so far as I am aware, except Burmeister, who has treated of them in a general way, but scarcely so as to allow of ready comparison between the families. Heer, also, in his work on the Fossil Insects of Œningen, has given in detail — and differing scarcely at all from what I have here presented — the mode of this venation in the Termitina. Besides

these, I do not know that any authors have given any specific distinctions of families among Neuroptera drawn from these characteristics.[1]

To enable us more readily to inquire how the two fossil forms under discussion are related to living types, we will reproduce some of the more striking of these characters in epitome, and append a similar brief account of the venation of the wings in the fossils.

Termitina. Nearly the entire wing is taken up with the simple and parallel branches of the *v. externo-media*, the anal area being wanting.

Embidina. The *v. mediastina* terminates near the tip of the wing by impinging on the *v. scapularis*, which impinges in the same way on the *v. externo-media*. The *v. externo-media* occupies the middle half of the wing with a few straight, simple, or dichotomous branches, distantly united by straight cross-veins to one another and to the veins above and below; anal area considerable.

Psocina. *V. mediastina* insignificant. The *v. scapularis* occupies almost the entire wing and is the only forked vein in it. It sends out a branch not far from the base, from which arise most of the branches, which curve and refork in the freest manner (though the wing is less crowded with veins than ordinarily), united by only one or two cross-veins to one another. The anal area is more prominent than the costal.

Perlina. The *v. mediastina* is connected with the margin by numerous cross-veins, and terminates by impinging on the *v. scapularis*. The branches of this latter occupy the apex only of the wing. It sends out a slightly diverging branch, which remains simple about half its distance to the margin, then sends out simple branches from its under side, seldom united by cross-veins. The *v. externo-media* branches like the branch of the *v. scapularis*, at about the middle of the wing, is connected by a cross-vein to that branch at its divarication, while the branches of the *v. externo-media* are themselves connected here and there by cross-veins and recurrent nervules. The *v. interno-media* forks several times, the consecutive upper forks continually reforking, and connected by a cross-vein at last to the *v. externo-media* at its first divarication. By this continual connection of the principal veins, two large cells are formed in the middle of the wing, the upper open, the latter filled with cross-veins in one sex; the last three veins are of not far from equal importance.

Ephemerina. The first three veins are simple. The *v. externo-media* occupies the largest portion of the wing, though it forks and reforks but once or twice, the spaces being filled by many intercalary nervures proceeding from the outer border. The *v. interno-media* and *analis* are about equal in importance, and similar in character to the *v. externo-media*, though with fewer intercalary nervures. All the nervures are generally connected by frequent, straight cross-veins.

Odonata. The most peculiar in its venation of all the families. The *v. marginalis* extends only to the middle of the wing, the *v. mediastina* taking its place beyond. The *v. scapularis* and *externo-media* are connected close to the margin by a cross-vein, from which arise two veins which occupy the greater portion of the wing. The *areæ marginalis, mediastina, scapularis*, and *interno-media* are traversed by numerous cross-veins. The most of the rest of the wing is filled with minute reticulations.

Sialina. The *v. scapularis* sends forth a branch in the basal half of the wing, which strikes

[1] When this was written I had not seen Goldenberg's paper on the carboniferous Insects of Saarbrück, (Die fossilen Insecten der Kohlenformation von Saarbrücken, aus den Palæontographicis von Dunker und Meyer, Cassel 4°. 1854,) which must be excepted from this remark, for so far as was necessary for the object he had in view, he has given detailed comparisons of the venation in some of the families of Neuroptera. I hope to revert at some future time to the relation which the species of the genus Dictyoneura there described bear to the Sialina and other Neuroptera.

the border on the outer half, but near its origin sends out a branch which forks, its upper fork continually reforking (the lower remaining simple and connected irregularly by occasional cross-nervures) and remaining parallel to the main stem. The *r. externo-media* forks near the middle of its course, the upper fork sometimes reforking. The *r. interno-media* forks widely at its very base, the upper fork sending out branches from its under surface. It is of considerable importance, while the *r. analis* is of but slight significance.

Hemerobina. The *r. scapularis* is generally much as in Sialina, but forks generally near to the base, and the branches are straight instead of curved, seldom united by more than one or two cross-veins, and these generally very regularly disposed, frequently united close to the margin and immediately forking again. It occupies also almost the entire wing. The other veins are much as in Sialina, but quite insignificant.

Coniopterygidæ. The veins never reach the border, and are extremely simple, but they nevertheless do not seem to agree in character with those of any other family. The only branching vein is the *r. scapularis*, which occupies half the wing. It sends out from its under side distant from one another one or two branches which fork widely near the margin, sometimes connected by cross-veins. It is connected to the *r. externo-media* by a cross-vein.

Raphidiidæ. The *r. scapularis* does not branch until beyond the middle of the wing, then sends out a branch which forks and is reconnected, before reaching the border, by a cross-vein which sends out several branches to the border. This vein thus occupies the apex of the wing. The *r. externo-media* occupies the central and largest portion. It sends out branches connected by cross-veins which latter themselves send out towards the border offshoots, which are sometimes again reconnected.

Mantispadæ. The *r. mediastina* impinges on the *r. scapularis* in the outer half of the wing. The *r. scapularis* sends out near together, in the basal half of the wing, two branches, the outermost of which sends out a branch parallel to the main stem, which again emits branches towards the border parallel to and equidistant from one another. These unite next the border and then fork again as in Hemerobina. This vein occupies more than half of the wing. The *r. externo-media* is much as in Rhaphidiidæ, but branches nearer the base. The anal area is quite insignificant.

Panorpina. The *r. scapularis* forks near the middle of the wing, its lower branch repeatedly forking. It occupies about one third of the wing, taking in all the apical portion. The *r. externo-media* forks in a similar manner but altogether beyond the middle of its course. The branches of the veins in general are mainly confined to the outer half of the wing, and they are connected by distant, straight cross-veins.

Phryganina. The *r. scapularis* sends from its lower side close to the base a branch, which forks near the middle of the wing, the branches being connected together afterwards by a cross-vein, which continues on and connects the branches of the *r. externo-media*. From this continuous cross-vein a considerable number of branches are sent toward the apex. This is nearly or quite the only cross-vein in the wing.

Hemeristina.[1] The *r. scapularis* sends downwards a branch near the middle of the wing, which curves outwards so as to run nearly parallel to the main stem, and sends from its under surface several other branches, occupying about a third of the wing. The *r. externo-media* divides near the base, and its lower branch forks when about half way to the border

[1] These names *Hemeristina* and *Palæopterina* are proposed for the families of which Hemeristia and Miamia are believed to be respectively members; fuller details, as a basis for a better comparison, are given beyond.

of the wing. The *r. interno-media* branches many times but at a very slight angle; and the *r. analis* is not unimportant. All the veins and their branches are intimately united by very frequent, straight, strong cross-veins.

Palæopterina.[1] Both the *r. scapularis* and *externo-media* fork not far from their origin very narrowly, the lower fork of the former and the upper fork of the latter sometimes reforking near the margin. Together they occupy scarcely more room than the *r. interno-media*, which at a distance from the base sends downwards more diverging branches which are occasionally united to one another and to the previous vein by distant, straight, but oblique cross-veins, as are also the branches of the *r. scapularis* to one another. The *r. analis* occupies considerable space, sending out many narrowly diverging forked branches not dichotomizing.

Other important distinctions, drawn from or dependent upon the structure of the wings, will be found to be characteristic of the families of Neuroptera. They differ, for example, in the various positions assumed by the wings when in an attitude of repose.

In the *Termitina* the wings in their natural attitude when at rest are extended horizontally backwards, those of the opposite sides completely overlapping one another. There is no deflection of the costal area, and the anal area being absent there is no plication.

In the *Embidina*, according to Westwood, the wings are matted down upon the abdomen as in the orthopterous family Forficularia. From figures of them one would judge that there was no deflection of the costal area and no plication of the anal area, and that their position may be exactly as in Termitina.

In the *Psocina* they are extended backwards, sloping obliquely from one another like the roof of a house, their inner edges meeting loosely, without plication of the anal area of the hind wings; anal area of fore wings with a slight horizontal deflection; no deflection of the costal area.

In the *Perlina* they are extended horizontally backwards, completely overlapping one another; the anal area of hind wings plicated; the costal area of fore wings slightly deflected.

In the *Ephemerina* they are extended perpendicularly upwards, the surfaces of the opposite wings approximate, or sometimes separated by a slight, seldom a considerable, angle; no deflection of the costal area; no plication of the anal area.

In the *Odonata* they are extended either laterally and horizontally, or (Agrionina) upwards, and, by the structure of the thorax, backwards, the surfaces of the opposite wings approximate; the anal area not plicated; no deflection of the costal area.

In the *Sialina* they are extended backwards, incompletely overlapping one another, arched over the abdomen; a single plication or none in the anal area of hind wings; a slight deflection in the costal area of the fore wings.

In the *Hemerobina* they are extended backwards, steeply sloping obliquely from one another like the roof of a house, their inner edges in close contact throughout; no plication of the anal area; the costal area not deflected.[2]

The *Coniopteryyida* and *Rhaphidiida* I have never seen alive, but they probably do not differ essentially from Hemerobina. Neither have I seen the *Mantispada*, but they are probably either as in Perlina, though without deflection or plication, or also without complete or any overlapping of the opposite pairs of wings as in Panorpina.

[1] See note on preceding page.

[2] But Savigny figures Nemoptera in an attitude like Ephemera.

In the *Panorpina* the wings are extended backwards horizontally or sloping slightly, the lower completely covered by the upper; the opposite pairs divaricate slightly, so as not to overlap one another at all, while the inner edges meet only along the basal half. The anal area is not plicated, nor the costal area deflected.

In the *Phryganina* they are extended backwards, steeply sloping from one another obliquely like a roof, at tip generally steeper, nearly vertical, and the opposite pairs appressed; the anal area of the fore wings deflected horizontally, those of the opposite pairs overlapping one another, the anal area of the hind wings plicated; the costal area not deflected.

In the *Hemeristina* the wings overlap one another horizontally very completely, even close to the base, probably arched over the abdomen, and probably with the sides protected near the base by the deflected costal area.

In the *Palæopterina* they overlap one another partially in a loose way horizontally over the abdomen, probably with no costal deflection, and in general as in the Termitina, though with not so complete an overlapping.

Some of the families of Neuroptera will also be found to differ in the position assumed by the wings of the pupa, as follows: —

Termitina. When developed more than as tubercles they are represented by Westwood as extended horizontally elongate over the abdomen, their inner edges touching at tip.

Psocina. Horizontally extended backwards in a level plane, not covering much of the abdomen, the posterior covered by the anterior.

Perlina. Same as in Psocina, but never covering any of the abdomen, the posterior being behind and not overlapped by the anterior.

Ephemerina. Curving backwards and upwards over the abdomen, the posterior covered by the anterior, the outer edges meeting along the median line.

Odonata. Projecting backwards in a level plane, somewhat deflected, the hinder edge downwards, those of either side parallel.

In the other families the wings are bent over, either curving over upon the breast or extended along the sides, the posterior partially or completely covered by the anterior, or with some modification of one or the other of these modes, so nearly the same as to make the distinctions valueless.

The families differ also from one another, but agree among themselves in the position of the head. In the Termitina, Embidina, Perlina, Sialina, and Raphidiidæ, the head is in the same horizontal plane with the body. In Psocina, Ephemerina, Odonata, Hemerobina,[1] Panorpina, Phryganina, Mantispadæ,[2] and Coniopterygidæ, it is in a plane vertical to that of the body. We do not know the position of the head in Hemeristina, but in Palæopterina it is horizontal.

From this review of the distinctions among the families we see that the *Hemeristina* are related to the Hemerobina and Sialina more than to any other, by the mode of branching of the *v. scapularis;* to the Ephemerina by the comparative importance of the *v. interno-media* and *analis;* to the Odonata by the character of the *v. marginalis* and *v. mediastina* in the basal half of the wing; to the Ephemerina again in the method of dispersion of the cross-veins;

[1] It may be noticed here that the larva of Myrmelion has the head horizontal.

[2] This is an additional reason why this should be separated as a family group from Raphidiidæ.

and to the Odonata in the strength and importance of the same; and once more to the Sialina in the form and manner of folding the wings; while it has distinctive characters, not only in the unusual combination of these peculiarities, but also in that the *v. marginalis*, *mediastina*, and the main stem of the *v. scapularis* are equidistant and parallel throughout, uniformly connected by straight cross-veins; in the peculiar curving of the principal branch of the *v. scapularis;* in the mode of branching of the *v. externo-media;* and in that the lower principal fork of the *v. interno-media* occupies more space with its branches, and is of more importance than the upper fork.

The *Palæopterina* show their relation to the Termitina in the character of the *v. mediastina* and the irregular cross-veins which run towards the margin; to the Termitina more than to any other, though not intimately, in the mode of divarication of the branches of this same vein; to hardly any unless it be the Panorpina in the peculiarities of the *v. externo-media;* to the Hemerobina and still more to the Sialina in the structure (though in Palæopterina given with more precision and exaggeration) of the *v. interno-media;* to the Ephemerina in the mode of branching, and to the Sialina in the important development, of the *v. analis;* to the Rhaphidiidæ more than to any other, though but slightly, in the infrequency and manner of dispersion of the cross-veins, excepting the marginal ones; and to the Termitina in the obliquity of all the cross-veins apart from those on the margin, and generally in the manner of folding the wings in repose. In the importance of the *v. interno-media* and *analis*, occupying as they do fully half the wing, we have characters which of themselves would clearly separate this family from the others; we also find distinctions of sufficient significance in every vein of the wing except the *v. marginalis* and *mediastina.*

We have thus far treated only of the structure of the wings. In the Palæopterina, however, we have other portions of the body to examine in addition to these, though their structure is generally scarcely as distinct as that of the wings, being crushed and displaced.

The contour of the abdomen is best preserved, though least so at the terminal segment, the most important part. It is apparently depressed; the roundness of the lateral edges of the segments indicate a membranous rather than a corneous, or even coriaceous integument, broad at the base, slightly increasing in breadth towards the middle and then tapering considerably to the apex, the terminal segment apparently furnished with a pair of short, stout, conical, anal stylets, — in all this corresponding in general to what we find in some Sialina. The meso- and meta-thorax are somewhat indefinite in their outlines, but the inequalities of the upper surface and the direction of the principal wing-nervures, which afford us an indication of the point of attachment of the wing, together with the faint sutural marks, show that it was similar in character in this part of the body also to the structure we find in Corydalis, one of the Sialina. The prothorax is quite remarkable for its diminutive size, its width being only half that of the mesothorax. We find similar abrupt changes in the Rhaphidiidæ, but in the Palæopterina the prothorax is not, as there, lengthened anteriorly as a compensation, but is formed much as in Perlina, depressed, quadrangular, with a slight median carina, but its anterior edge produced in the middle to quite a prominent tooth. The anterior legs are wanting,[1] but both the other pairs are present in fragments, enough to show that they were of moderate length and strongly compressed,

[1] It will be seen in our description of the anterior legs and of the head, that we interpret these parts very differently from Professor Dana in his article in *Silliman's Journal.* The reasons for this we have given elsewhere. See *Amer. Journ. Science*, (2) XL: 268.

recalling vividly the Perlina. The outline of the head is partly very distinct and partly very indistinct, and is docked posteriorly by what indistinctly resembles the posterior two segments of the abdomen of another insect. It is depressed like the other parts of the body, and regularly ovoid in outline. The eyes are rather large, elongate, lateral. The other appendages of the head cannot be made out distinctly enough for any characterization, the only possible indication of antennæ being slight linear depressions in the stone. In those points which can be seen the head closely resembles the Perlina.

The only portion of the body besides the wings which is preserved with any distinctness in the Hemeristina is a fragment of a femur, which from its position on the stone may be assumed to belong to the anterior pair of legs. It is compressed, with a slightly swollen median ridge, as the femora of Palæopterina are. There is also an apparent fragment of a middle femur and tibia at their union, very indistinctly preserved. The most that can be said about it is that it seems to agree with the same parts in Palæopterina.

Now what is most interesting in this connection is, that the Neuroptera have been divided by Erichson, in this being followed by at least the German Entomologists, into two groups, called respectively the Neuroptera (comprising the families Sialina, Hemerobina, Coniopterygidæ, Mantispadæ, Rhaphidiidæ, Panorpina, and Phryganina), and the Pseudo-neuroptera (which include the Termitina, Embidina, Psocina, Perlina, Ephemerina, and Odonata), founded principally upon one very essential characteristic, — the complete or incomplete metamorphosis, *i. e.*, whether the pupa be inactive or active; in which latter case the rudimentary wings of the pupa are mere pads protruding horizontally or more or less deflected from the thoracic segments, and in the other are more developed and wing-shaped, encircling the sides and folded over upon the breast like Coleopterous pupæ; and in support of the naturalness of this division it is urged that in no other sub-order of Insects do we find existing simultaneously two so distinct forms of metamorphosis.[1]

We have already seen, by the comparison of the wings alone, that these two families of fossil Neuroptera borrowed from one and another of the other families characteristics of wing-structure, which show their close affinity to them. These families from which they were borrowed, will now be seen to belong, some to one and others to the other of these larger groups, proving that we have in our newly discovered families a Synthetic Neuropterous Type. And this is still more evident when we carry our comparisons into other parts of the body, as we may in the Palæopterina, where the meso- and meta-thorax and the abdomen remind us strongly of the Sialina, a Neuropteron, while the head and eyes, the prothorax and legs, quite as much bring the Perlina, a Pseudo-neuropteron, to our mind.

In the Hemeristina we have nothing of importance in this direction; but the femoral fragments agree so closely with the Palæopterina in its mimicry of Perlina as to lead us to suggest that in its other features it may also have followed somewhat the peculiarities of the Palæopterina in the equal distribution of its characteristics over a field embracing both the Neuroptera and Pseudo-neuroptera.

We shall have completed the task we have assumed when we have given in detail the

[1] I cannot, however, discover any one character common to the wing-structure of one of these two groups which is not found in the other as well, though the families of Pseudo-neuroptera are much more distinct from one another than in general are those of the Neuroptera among themselves; unless it be that the Phryganina are as widely separated from the more nearly related families as those of Pseudo-neuroptera are from one another.

characters of the families, genera, and species of the fossil insects referred to in the previous remarks.

Family Palæopterina Scudder.

Neuroptera of medium size. Body rather broad and flat; the head horizontal. Head oval, depressed; eyes rather large, elongate; thorax square and depressed; the prothorax and head much narrower than the rest of the body; legs compressed, not long; abdomen full, long, probably (like Corydalis) not corneous; the terminal segment probably with a pair of very short anal appendages.

Wings large and regularly rounded, very broad near the base, the two pairs nearly equal, extending beyond the abdomen, and when at rest both pairs reaching about the same point; with only a very few and slight cross-veins, except in the *area marginalis*, where they are numerous and irregular; when at rest, folded as in the Sialina.

The *v. mediastina* runs parallel to the *v. marginalis*, but not in close proximity to it. It terminates at about two thirds the distance to the apex by impinging on the *v. scapularis*, which runs parallel and quite near to the *v. mediastina*, reaching the margin just before the very extremity of the wing. The *v. scapularis* forks at about one fourth its distance from the base, the upper fork taking the direction mentioned and remaining simple, the lower diverging but little though with constant increment, forking at about three fourths the distance from the base, the forks reforking one or more times. The upper branch is connected by a few oblique cross-veins with the lower, which run outwards and downwards. The *v. externo-media* forks quite near the base, its branches but slightly divergent, sometimes forking again. The *v. interno-media* covers with its branches a wider space. It is at first about as divergent from the last as that is from the lower branch of the *v. scapularis*. It soon forks, the upper branch again forking twice, the forks remaining parallel but separated from one another at the start as widely as those of the previous vein at their termination. There are one or two cross-veins uniting these forks, and one or two uniting the upper branch to the lower branch of the previous vein, where it comes in close contiguity. Of the *v. analis* little can be said, except that it terminates in a large number of closely contiguous, parallel nervures, which arise from forks near the base, which seldom refork, the branches running parallel to the innermost branch of the *v. interno-media*. The *area marginalis* has a large number of irregular cross-veins curving outwards from the *v. mediastina*, as in many Termitina. The wings are quite alike and weak. In the specimen they are in their natural attitude of repose, overlapping one another in a loose way upon the back, probably with no side support.

Genus Miamia Dana.

Head ovate; eyes oblong-ovate, situated on the sides in the middle, slightly approximate anteriorly, prominent above and below but not protruding laterally beyond the general contour of the head; prothorax as wide as the head, quadrangular, broadest anteriorly, the anterior border very much produced forwards into a median projection, both anterior and posterior angles prominent but rounded, the posterior border square; meso- and meta-thorax much broader than prothorax, with large, slightly elevated tubercles just within the base of the wings, as in Corydalis; middle and hind femora and tibiæ broad and not long, femora and tibiæ of equal length; abdomen large and plump, as in Corydalis, the basal joints not quite so large as the central, tapering regularly, though but little, from the

middle to the tip; last joint considerably smaller than the penultimate, furnished apparently with a pair of very short, bluntly conical, anal appendages. The costal border of the wings is almost perfectly straight, till near the tip, at a point just before reaching the tip of the abdomen when the wings are at rest, where it begins to curve. The inner border begins to form an opposite curve at a corresponding point, and together they form a curve of perfect regularity with no angle whatever. The inner border is straight for some distance from this curve towards the base, the wing growing but slightly narrower till near the base, when it narrows suddenly, but (probably) with a regular curve.

The cross-veins connecting the branches of the *v. scapularis* are only two or three, running obliquely downwards and outwards from the upper to the lower branch at equal distances from one another, and the outer at a similar distance from the forking of the lower branch. The cross-veins, between the branches of the *v. interno-media*, run parallel to the inner margin between the extremities of those branches. The cross-veins are very slight, and in the case of those in the *area marginalis* are very irregular in direction and disposition, like the same space in the Termitina. In the other parts of the wing the two or three scattered ones in the places mentioned are regular and straight.

Miamia Bronsoni Dana.

Measurements: head, .10 in. broad; length of eye, .08 in.; length of prothorax, including front projection or tooth, .15 in.; breadth of meso-thorax, .25 in.; from the hinder edge of prothorax to the extremity of the abdomen, 1.12 in.; breadth of middle femora, .05 in.; length of hind femora (what is seen of them), .33 in.; breadth of same, .07 in.; length of hind tibiæ, .18 in.; breadth of same, .04 in.; expanse of fore wings, 2.16 in.; expanse of hind wings, 2 in.; extreme breadth of fore wing, .40 in.; length of the anal appendages, .05 in.

Head just twice as long as broad; prothorax of the same width as the head, the front border convex, produced considerably forward in the middle to a pointed and rather slender tooth, a very slightly impressed median carina extending the whole length of the prothorax, a scarcely perceptible linear impression crossing the hinder portion, starting from a little in front of the posterior angle and curving forward so much that the broad, straight, scarcely elevated ridge connecting its two extremities is equally distant from it and the hind border of prothorax; the sides of prothorax very slightly convex, the prothorax itself about five sixths as broad posteriorly as anteriorly. Femora (front legs wanting) broad, slightly swollen along the middle line, flat upon either side, the extremities docked, the angles slightly rounded. Tibiæ much narrower, with no median ridge except in the hind tibiæ, where it is slight in the middle. Wings in repose reaching the same point.

Family Hemeristina Scudder.

Neuroptera of large size. The prothorax is quadrangular, narrower than the meso- and meta-thorax, though not proportionally so much so as in the Palæopterina; the femora (probably the front pair) are as in the Palæopterina, but proportionally broader.

Wings large, long, about twice as broad beyond the middle as near the base, the costal border convex in its outer half, with numerous and prominent cross-veins, but no reticulations; when at rest, overlapping quite completely even close to the base, much as in the Perlina, and probably with the sides protected near the base by the deflected *areæ marginalis et scapularis.*

The *v. mediastina* and *v. scapularis* run nearly parallel to each other throughout their course. The *v. scapularis*, at about one third the distance from its origin to the apex, sends out a branch, which curves outwards and considerably downwards, again curving upwards, so that when about two thirds the distance from the base it is as far from the main stem as that is from the front margin; beyond this, it keeps apparently parallel with the main stem; at the deepest part of its curve it sends out a branch about as divergent from it as it was from its parent stem, which continues directly to the margin, and again, but a short distance further on, it sends forth another, which runs parallel to the former. The *v. externo-media* is found a short distance from the base in close contiguity with the *v. scapularis*, but forking as it separates from the former, the upper branch continues a short distance in close contiguity to it, and then passes unchanged to the border of the wing parallel to the lowermost branch of the *v. scapularis;* the lower branch runs in a direction parallel to the general course of the upper, and forks once a little more than half way to the border. The *v. interno-media* forks at its origin, both forks running very nearly parallel and in quite close contiguity to one another, and parallel to, but rather distant from, the lower branch of the *v. externo-media.* The upper fork again forks at a little distance from the origin, the forks keeping in close contiguity. The lower fork sends off from its lower side one or two slightly curving, rather divergent branches. Of the origin and branching of the *v. analis* little can be said; the branches are rather numerous and distant, and subparallel to the lower fork of the *v. interno-media* as continued in its first branch, and the area covered by it is large and well developed. All of these veins and branches are connected together by numerous cross-veins, which are quite prominent, equidistant, and equally distributed throughout the wing, much as in most Ephemerina.

The lower wing differs from the upper, so far as can be determined, in that the branch of the *v. scapularis* does not curve towards the main stem, and that there are other branches to the *v. scapularis* beyond the first, parallel to that. The veins below this were not easily distinguishable.

Genus Hemeristia Dana.

Prothorax equally wide throughout; the sides straight; the anterior and posterior borders slightly if at all convex; (fore ?) femora as in Miamia, but proportionally broader, though with the same flat surface on each side of a slightly swollen middle ridge.

Wings of large size, probably extending considerably beyond the body, the costal border probably quite straight during the first part of its course, curving broadly towards the extremity, probably with the extremities rounded and without a pointed apex, and with a full anal area and angle. The second branchlet of the principal branch of the *v. scapularis* in the upper wing, previous to the origin of the third, is connected with the principal branch by sinuate cross-veins as frequent as the cross-veins in other parts of the wing.

Hemeristia occidentalis Dana.

The prothorax here is so indistinct and poorly defined as to be incapable of specific description, or of measurements. Mesothorax, .25 in. broad; the fragment of the (fore ?) femur is .10 in. broad. The wings, too, being but partially preserved, it is impossible to give accurate measurements, save of parts within a wing. The probable expanse is 5.15 in.; the distance, when the wings are at rest, between the first branching of the *v. scapularis* on one wing and that on the other upper wing, is .50 in. The estimated breadth of

each wing at its widest point, probably the same as that between the margins of the wings at rest at their widest point, is .85 in.; the distance between the origin of the principal branch of the *v. scapularis* of the upper wing and that of its second branch is .53 in.; the greatest width of the space between the *v. scapularis* and its principal branch in the upper wing is .11 in.; and the distance between the *v. scapularis* and the margin at this same point is .09 in. The figure answers better than description.

In this specimen the right upper wing overlaps the left upper wing, and the insect is seen from above.

Explanation of the Plate.

Fig. 1. — The right upper wing of *Hemeristia occidentalis* restored, magnified 1½ diameters.

Fig. 2. — Restoration of *Miamia Bronsoni*, magnified 2 diameters.

The dotted lines in these two figures show the conjectural parts.

Fig. 3. — The four wings of *Hemeristia occidentalis* as seen in the fossil, magnified 1½ diameters.

Fig. 4. — The veins of the wings only of *Miamia Bronsoni*, as they appear in the fossil, magnified 2 diameters.

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On the Carboniferous Myriapods preserved in the Sigillarian Stumps of Nova Scotia.

AMONG the most curious and interesting results of Dr. J. W. Dawson's researches in the ancient fauna and flora of Nova Scotia is his discovery, in the carboniferous strata at the "Joggins" mine, of erect sigillarian stumps, whose cavities enclosed, with the debris of those ancient times, the relics of a fauna otherwise quite unknown. The land-shells and gally-worms — than which none are known of older date — with fragments of hexapod insects, which had nourished the reptiles of that period and are now preserved in their coprolites, indicate, from their nature and comparative abundance, a fauna of considerable magnitude; three stumps alone, Dr. Dawson informs me, have yielded the articulate remains which I have examined.[1] The gally-worms occur mostly in fragments of from three or four to about sixty segments; but also in smaller bits, enclosed in the masses of reptilian coprolites; hexapod insects scarcely appear except in the coprolites, and although they unquestionably belong to Orthoptera and Neuroptera (of small size), they are in general too fragmentary to justify one in predicating anything of their generic affinities.

In this paper attention is directed to the Myriapoda alone. These were originally referred by Dr. Dawson to a single species and described under the name of *Xylobius sigillariæ*.[2] Greatly to my surprise, I found, on examining them, that they represented not only several species, but two genera of gally-worms. Urged by the doubts both of Dr. Dawson and myself, I subjected the specimens to repeated and most minute inspection, but found my previous opinion confirmed at every step.

The condensed description, originally given by Dr. Dawson, is as follows: —

"Body crustaceous, elongate, articulate, when recent cylindrical or nearly so, rolling spirally. Feet small, numerous; segments thirty or more; anterior segments smooth, posterior, with transverse wrinkles, giving a furrowed appearance. In some specimens traces of a series of lateral pores or stigmata. Labrum? quadrilateral, divided by notches or joints into three portions. Mandibles two-jointed, last joint ovate and pointed. Eyes ten or more on each side." Quart. Journ. Geol. Soc. London, xvi., p. 272.

In stating that the anterior segments were smooth, while the posterior were provided with "transverse wrinkles," Dr. Dawson seems to have drawn his conclusions from a com-

[1] The opportunity of studying them I owe to his kindness.

[2] For previous writings on "*Xylobius sigillariæ*" see:

Dawson, J. W. Quart. Journ. Geol. Soc. Lond., xvi, 268–273, figs. 4–9 (figs. 5, 6, 8, *A. xylobioides*; fig. 9, *X. sigillariæ*); ibid., xviii, 6; ibid., xxii, 116; Air Breathers of the Coal Period, 62–64, 67, pl. vi, figs. 57–61 (figs. 57, 61, *A. xylobioides*; fig. 59, *X. Dawsoni*; fig. 60, *X. sigillariæ*); Can. Nat. and Geol., viii, 280, 283, pl. vi, figs. 57–61 (same as previous); Acad. Geol., Suppl., 33, 34, 36, fig. 45 (*A. xylobioides*); ibid., 2d ed., 385, 386, fig. 151, (fig. 151*b* *A. xylobioides*; fig. 151*c* *X. sigillariæ*).

Woodward, H. Trans. Geol. Soc. Glasg., ii, 235–237, pl. iii, figs. 11–13 (figs. 11, 11*a*, 13, 13*a*, *X. Woodwardi*; fig. 12*a*, *A. xylobioides*).

Scudder, S. H. Dawson's Acad. Geol., 2d ed., 495–496; Geol. Mag., v, 21*c*.

parison of specimens in which the anterior segments only were preserved, with others which he considered posterior segments; but every specimen I have seen either is or is not smooth throughout the whole length of the fragment, and there are quite a number of fragments in which more than half the body is preserved; this distinction is the one upon which I would base my division of these millipedes into two genera. In one (for which the name of *Xylobius* may be retained, since it comprises the larger number both of species and of specimens) the segments composing the body are broken up by longitudinal sutures into little quadrangular plates, of varying form and proportion, which, for want of a better name, I have designated below as *frustra*, and which, to the best of my knowledge, are wanting in any living Myriapoda.[1] In the other, which may be called *Archiulus*, the segments are apparently composed mainly of one unbroken piece, as in recent myriapods. Other distinctions between these groups will doubtless be found; but the imperfect preservation of the fossils — not one of them approaching completeness — forbids their present discovery. In the meantime it does not seem unreasonable to consider this feature alone in the structure of the segments of sufficient importance to separate the groups generically.

Of the genus *Xylobius* four species may be distinguished among the remains from Nova Scotia. For the species best represented both in numbers and in the character of the specimens, I have retained the original name applied by Dr. Dawson.

Xylobius sigillariæ Daws.

There are no large fragments of this myriapod and but few that throw any light upon the form of the terminal portions of the body; the specimens are usually more or less coiled, and the largest, which is 28 mm. in length, is curved in the form of a semi-circle.

[1] Mr. Edward Burgess has called my attention to a myriapod, *Spirostreptonlactarius* (Say) Brandt, which presents a somewhat similar appearance; the segments in this peculiar chilognath bear frequent, longitudinal ridges, very elevated and strongly compressed, the altitude of every other one being double that of the intermediate; the segments are divided by these ridges into quadrilateral sections of much the same proportions as the frustra of *Xylobius sigillariæ* Daws.; but since these sections are perfectly continuous (undivided by any sutures) they can bear no structural affinity or homology with the frustra of *Xylobius*.

Another instance may be seen in *Trachyjulus ceylanicus* Pet. from Ceylon, specimens of which Professor Humbert has kindly given me an opportunity of examining, and which are thus described by him (Essai sur les Myriapodes de Ceylan, pp. 43–46, pl. iii, figs. 18, 18*a*–18*h*); "Each segment is divided into three successive regions; the front one, formed by the articular portion (prozonite), fits into the preceding segment and is regular and smooth; behind it is an annular region marked by numerous projecting longitudinal lines; finally the hinder part of the segment is prominent and furnished with strong longitudinal carinæ, each formed of two sharp spinous tubercles, placed one behind the other and united at their base. These carinæ succeed each other in regular lines from one end of the body to the other, and thus form strong longitudinal ridges which follow those of the first segment. The ridge formed by the median dorsal carina is slightly pronounced; on each side of it are two stronger ones; the second lateral carina projects more strongly than the others, and arises on each side of a strong, black, cylindical tubercle, which is truncated at its summit, where the foramen repugnatorium opens, and followed behind by another smaller sharp tubercle, obliquely docked at the edge; below this series of tubercles, there are five or six other rows, diminishing gradually in size toward the base of the legs." Humbert further states that, in this sculpturing of the segments, *Trachyjulus* greatly resembles *Glyphiulus granulatus* Gerv. from Mauritius.

Markings similar to the sutures dividing the frustra are found in all Iulids in the lines of growth on the lower borders of the sides of the segments; but these invariably become indistinct, and finally invisible at a short distance from the lower border of the segment, and, moreover, never traverse the segment in a straight line, but in a curve across the lower anterior angle, or in lines parallel to such a curve; they are also closely approximate, while the division lines of the frustra are at comparatively wide intervals — altogether too wide to be mistaken for these lines of increment.

The body is cylindrical, of uniform width throughout the principal part and tapering a little at either end; none of the specimens, however, are sufficiently well preserved to ascertain in what degree or over how great an extent the body tapers; one specimen, which shows the posterior three or four segments quite clearly, tapers from 1.05 mm. to 1.5 mm. in breadth in a distance of 1.125 mm.; another fragment occurring in the middle of the body is 18 mm. in length and of uniform breadth throughout. It is of course impossible to determine of how many segments the body was composed, but the largest fragments number twenty-seven and thirty segments, respectively, and the body was probably furnished with at least forty or fifty; the breadth of the body varies from 2.25 mm. to 3.5 mm., and generally averages about 2.75 mm.; at the posterior extremity, however, it measures only 1.15 mm. The segments of the body are a little convex, and measure from .7 mm. to more than 1 mm. in length, averaging .87 mm., the length being to the breadth as 1 to 3.441. The surface is smooth, and both the anterior and posterior borders appear to be slightly incrassated.

The frustra are quadrangular in shape, extend regularly across the segments and are always more than twice, and often more than thrice, as long as broad; in segments which measure from .7 mm. to 1.05 mm. in length, the frustra vary in length from .2125 mm. to .45 mm., and average .29 mm., the breadth being to their length (on an average) as 1 to 3.043; they are so arranged down the sides of the segments that the upper edge of each is always a little higher than the lower edge of the next frustrum above; except in partaking of the convexity of the segment, they are flat.

A single specimen seems to show a slight circular depression in the centre of one of the frustra, which occurs about half way up the sides of the segment; it resembles and is found in the place of the lateral pores.[1] There are two pairs of legs to each segment; they arise in close proximity, and apparently not from the middle of the segment, but from the middle of its anterior half (possibly its posterior half — which, cannot be determined from the imperfect nature of the fragments); they are very long and slender and of nearly equal breadth throughout, tapering at the tip; they vary, probably in different parts of the body, from .6 mm. to 1.45 mm. in length,[2] and the largest are .075 mm. broad: they are apparently composed of five joints; of these the terminal is the longest; the first and second are equal and next in length, and the fourth is the smallest of all.[3]

Xylobius similis sp. nov.

The form of this animal does not seem to differ much from that of *X. sigillariæ* Daws. In one or two specimens, which show some of the terminal segments, the extremities are a little smaller than the middle of the body, the diameter diminishing near the head, in a distance of about 11 mm., from 5.5 mm. to 4 mm.; the hinder end tapers from 3.5 mm., at a distance of 3 mm. from the extremity, to 2.75 mm. at the extremity itself. The number of segments on the fragments vary from twenty-seven to at least forty, and in one specimen apparently to sixty, while in none of them are all the segments preserved.

[1] *Foramina repugnatoria* of Waga.

[2] The length of the legs in this and all subsequent measurements, refers to the distance to which they extend beyond the crushed body.

[3] This statement concerning the joints is doubtful, being based on a single instance, not clearly defined.

The specimens vary in length from 18 mm. to 38 mm., and in breadth 1.5 mm. in minute, probably young, specimens to 5.5 mm. in very large ones; usually they are about 3.5 mm. broad. The segments are a little more convex than in *X. sigillariæ* Daws., and (with one exception, where the segments vary from .165 mm. to .175 mm. in length, and the body is only 1.5 mm. broad) vary in length from .55 mm. to 1.3 mm., where the body ranges from 2.5 mm. to 5.5 mm. in breadth; the average length of the segment to its breadth is as 1 : 5.574. The segments are ordinarily smooth, but sometimes appear to be coarsely, irregularly and very faintly scabrous; they are but slightly, if at all, incrassated at the anterior and posterior margins.

The frustra are quadrangular in shape, cross the segments regularly and are generally a little less than twice as long as broad; except in the case of the small specimen already alluded to (where they are .087 mm. in breadth), they vary from .275 mm. to .75 mm. in breadth; in segments, the lengths of which vary from .55 mm. to 1.3 mm. the frustra average .55 mm. in breadth, and the breadth is to the length as 1 : 1.0. As in *X. sigillariæ* Daws., they are flat, except as they partake of the convexity of the segments, and their upper edges are slightly prominent.

Besides the cross lines upon the segments, indicating the division of the frustra, finer, fainter, parallel and more frequent impressed lines are occasionally seen; some which were measured were .0125 mm. broad, and on an average 1 mm. apart. In one specimen I found a whitish substance, which appears to be the altered chitinous coat of the animal, and in this were alternating elevations and depressions crossing the segment, at distances varying from .1 mm. to .175 mm. apart; they are in direct continuation of the fine lines mentioned above, which at this point vary similarly in distance; they differ, however, in that the first mentioned lines are sharply defined furrows, separated by broad plane surfaces, while these are dull grooves between alternating slopes of elevation; in the latter also, the lines of depression are deepened and broadened at regular intervals, giving the whole field a maculate, pitted appearance, apparently found in other chitinous spots, which bear no trace of the lines; it may be noticed that these various sculpturings usually occur on segments near the head and on the lower half of the body.

I have not found any trace of foramina, nor are any legs visible, with the exception, in a single instance, of what seems to be a basal joint; it is .175 mm. broad, or much larger than in *X. sigillariæ* Daws. In one specimen, in exactly the place where the eyes should be, an aggregation of minute tubercles may be seen, arranged in five parallel rows, each row containing from two to five tubercles; very probably these are only accidental roughnesses on the stone.

Xylobius fractus sp. nov.

I have seen but three fragments of this gally-worm, and my knowledge of its structure is correspondingly limited; only one fragment shows what may be an anterior or a posterior end, or both, and it is so imperfectly preserved that one cannot be sure whether the lessening breadth of the extremities is real or accidental. The largest specimen — and this is parted in such a way that it may have belonged to two individuals — is slightly curved in position, 25 mm. long, and composed of forty-five rings, the longer portion counting twenty-eight; another fragment, 7 mm. in length, is composed of sixteen seg-

ments. The body ordinarily varies from 3.5 mm. to 3.75 mm. in breadth, but is sometimes so much distorted as to be only 2.25 mm. broad. The segments are still more convex than in *X. similis* Scudd., exceedingly short, and vary in length from .425 mm. to .675 mm., averaging about .58 mm. only; in other words, the average length of the segments to their breadth is as 1 : 5.617; the surface does not present any noticeable irregularities, and neither the anterior nor posterior margins appear to be thickened.

The frustra are quadrangular in shape, cross the segments regularly and are very nearly square, save at the lower portion of the sides of the body, where they become almost twice as long as broad; they vary in breadth from .275 mm. to .5 mm. averaging .42 mm.; their average breadth is to their length as 1 : 1.353; except in so far as they partake of the convexity of the segments, the frustra are flat, but the upper edge of each is very slightly raised above the surface of the contiguous frustrum. The fine lines which were noticed in *X. similis* Scudd., are also found in this species (probably they are common to all), and occur invariably on the lower half of the body only; in distance apart they vary from .038 mm. to .1 mm., being usually about .075 mm. In one individual, where only one or two segments are preserved, a slight depression, probably a lateral pore, may be seen in the centre of one of the middle frustra of each segment. Only one specimen, and that a very small fragment, preserves any sign of legs; they seem to agree in general with those of the species previously described, but the different joints cannot be distinguished; there are apparently two pairs to each segment; they are 2 mm. in length, and near the base measure from .0625 mm. to .0875 in breadth.

Xylobius Dawsoni sp. nov.

The only representatives of this species before me are two admirably preserved single segments and a crushed mass of contiguous segments, all from the middle of the body; even in the latter case, there are not enough segments to show the form of the body; the parts preserved measure 23.5 mm. in length, are composed of about twenty-five segments, and are of uniform breadth throughout, measuring in this direction 3.5 mm. The segments are quite peculiar, and, if we except their being broken into frustra, resemble very closely those of the single species of the genus *Archiulus*, described further on. The portion of the segment lying, in repose, beneath the adjoining anterior segment (I say anterior by assumption, for the remains themselves do not prove anything), is flat, or nearly so — perhaps slightly concave; while the exposed portion is first (anteriorly) strongly and abruptly convex, making a narrow prominent ridge across the body, and occupying a little more than one-fourth of the length of the exposed portion of the segment, and then regularly and broadly, but rather deeply, concave along the remainder of the segment. The segments are longer than in the other species, varying from 1.15 mm. to 1.65 mm. in length, and averaging 1.5 mm.; but the portion concealed by the overlapping of the contiguous segment, .4 mm. in length, is not given in the measurements of the previously mentioned species, and for comparison with them, must be subtracted; this leaves the average length of the exposed portion 1.1 mm., and the average length of the segment to its breadth as 1 : 3.4. The exposed surface of the segments is provided with a very faint, minute and indistinct punctulation; and also with fine, indistinct lines of sculpture, .25 mm. apart, running parallel to each other and to the anterior and posterior borders of the segment.

The frustra are not regularly quadrangular, as in all the previous species, but the lines of division in crossing the segments curve slightly, and divaricate a little as they pass from the anterior border. If these frustra could slide over each other, as the specimens seem to show, the animal could coil itself more readily and completely than the other species of this genus; the frustra vary in breadth, increasing, in general, in one direction, but whether upwards or downwards, the nature of the remains does not permit us to judge; in the two separate segments they varied thus: first (visible only in one) .35 mm. by .9 mm.;[1] second, .35 mm. to .675 mm., by 1.05 mm. to 1.25 mm.; third, .5 mm. to .875 mm., by 1.1 mm. to 1.25 mm.; fourth, .575 mm. to .7 mm., by 1.25 mm.; fifth, .5mm. to .925 mm. by 1.3 mm. to 1.5 mm.; sixth, .675 mm. to .9 mm., by 1.25 mm. to 1.55 mm.; average .59 mm. to .815 mm., by 1.14 mm. to 1.36 mm., or .7025 mm. by 1.25 mm. Both edges of the exposed portions of the frustra are raised — that which seems to be the upper one to a considerable degree; so that, besides partaking of the varying contour of the segment, the frustra are slightly and oppositely concave; the lines dividing the frustra run through the concealed, as well as through the exposed portion of the segment, but, in the former case, they do not have their edges raised, and the lines of separation are straight, less distinct, and run at right angles to the anterior border of the segments. The concealed portion of the segment is also provided with fine impressed lines crossing it at right angles to the anterior border of the segment; they are placed at an average distance of .075 mm. apart, but every other one is more deeply impressed and conspicuous. Although some of the specimens are remarkably preserved, I have been unable to detect any trace of lateral pores, and no legs can be seen on any of the fragments. The well preserved single segments are probably from the region near the head where lateral pores do not occur.

The genus *Archiulus* has but a single representative among these sigillarian relics; in general appearance it resembles the last mentioned species, and may be called

Archiulus xylobioides gen. et sp. nov.

As this species includes some of the best preserved and most completely coiled specimens among the fossils, nearly every part of the body can be seen in a more or less perfect manner. Excepting at the two ends, the body must have been of nearly uniform width throughout; at about the seventh segment it begins to taper anteriorly, at first gradually, afterwards quite rapidly, so that the segments adjoining the head are scarcely more than half the width of those in the middle of the body; the head itself appears to be well rounded, and to have no ridge or crest; apparently the body tapers neither so rapidly nor considerably at the posterior end, although the fragments of this part are less perfectly preserved. None of the fossils exhibit all the segments of the body, but vary in length from 7 mm. to 26.5 mm., and in the number of segments from nine to thirty-three; probably full grown individuals had as many as forty or forty-five segments. The middle of the body varies from 2.5 mm. to 4.5 mm. in breadth, averaging 3.4 mm.; in one instance, at a distance of 15 mm. from the head,

[1] The shorter measurement is the breadth of the frustrum, the longer its length; when two sets of measurements are given, the first in every case refers to the same specimens.

it measured 4.25 mm., and at a distance of 7.5 mm., 3.25 mm.; at 5 mm. from the head it measured 2.5 mm. (the average breadth at this point is 2.375 mm.), and next the head 1.62 mm. One specimen, closely coiled, the body of which at its widest part was 2.75 mm. in breadth, measured 4.625 mm. across the coil. Beneath, there is a faintly impressed line along the middle of the body, on either side of which the lines of divisions of the segments are inclined a little posteriorly. The segments are shaped much as in *X. Dawsoni* Scudd., but are not broken up into frustra; the anterior ridge is more prominent, and occupies a greater extent of each segment in the anterior part of the body, and especially in the first seven segments, than in the posterior part; and when the body is coiled, the hinder edges of the segments project strongly above the adjoining ring, much as it is represented in some of Dr. Dawson's illustrations; other fragments show that the lower edges of the segments were well rounded posteriorly; the segments are proportionally a little longer close to the head than in the middle of the body; in general they vary in length from .8 mm. to 1.5 mm., averaging 1.28 mm. (but one segment, near the head, in a small specimen, measured only .475 mm.), while the breadth varies from 1.62 mm. to 4.5 mm.; the average length of the segment to the breadth is as 1 : 3.05; the ridge occupies from one-fifth (in the middle of the body) to nearly nine-twentieths (near the head) of the entire length of the segment. In some specimens, which seem to be a little worn, the surface is perfectly smooth, but in others the altered integument is apparently marked with broad, shallow, circular, tessellated pittings, the centres of which are .0875 mm. apart; there are fine, parallel, longitudinal lines on the segments, varying from .04 mm. to .2 mm. apart; those on the under surface, or on the lower portion of the sides of the segments, seem to be in closest proximity, but the lines on the upper surface are sometimes not more than .875 mm. apart.

The foramina repugnatoria are more distinctly preserved in some specimens of this species than in any of the other fragments of fossil myriapods which I have examined; they occur from the seventh segment backward (I could not determine how far, but at least to the seventeenth segment), and are placed in the middle of the sides of the segments; they are oblong oval in shape, with their longer diameters vertical; the mean of their diameters averages .2 mm. A specimen of the under surface seems to show that the legs are inserted close together, one a little outside the other; together they are placed in the middle of the anterior half of the segment, and about midway between the ventral line and the outer edge; they vary in length according to their position on the body; on the fifth segment, where they commence, they are from 1.35 mm. to 1.8 mm. long, while at the middle of the body they measure from 1.75 mm. to 2 mm. long; at the base they average less than .1 mm. broad.

I cannot determine whether the animal had any eyes, but the tubercles delineated by Dr. Dawson cannot be considered as such, for an examination of his original specimen shows, as his illustration itself indicates, that these tubercles are placed in the segment behind that which should bear the eyes; and, moreover, similar tubercles may be seen on other segments, and indeed on other parts of the stone where there are no organic remains; in another spot, close to the base of the antennæ, and exactly where Newport represents the eye of the immature Iulus, two or three minute tubercles, .0167 mm. in diameter, are situated close together at the upper edge of an abrupt pit in the stone, which — if these are parts of the eye — has engulfed the rest; these are the only possible indica-

tions of eyes which I have been able to find. There are, however, two fragments of antennæ; one is broken and parted, and simply indicates that the original was probably at least .9 mm. long, and in one place .2 mm. broad; the other is comparatively well preserved, and shows that the fossil myriapod preserved in its maturity the simple form of antenna, now characteristic of adolescence; it seems to be 1.3 mm. long, and is composed of four joints, forming two parts somewhat similar in appearance; the first and second joints together have an oblong oval, well rounded outline, and run in a nearly straight direction; while the third and fourth have a somewhat similar outline, but are a little curved, lunate or reniform; that is, the first and second are connate (or at least in no degree moniliform), as are also the third and fourth, while a deep constriction nearly divides the second and third; the exact shape of the first cannot be determined, but it appears to be a little larger at the apex than at the base, and about as long as its extreme width;[1] the second is docked squarely at the base, and is of equal width for a short distance, when it tapers gradually to a well rounded apex, where it unites with the third; it is .4 mm. long, .3 mm. broad at the base, and .1625 mm. broad at the tip; the third, which forms almost the whole of the outer half of the antenna mentioned above, is .6 mm. long, and .375 mm. in extreme breadth; it is broadest in the middle, and tapers toward either end, being .15 mm. broad, where the minute apical joint is connate with it; the fourth, or apical joint, is but .1 mm. in length, only serving to round off the tip of the antenna; were it not for the deep constriction at the middle of the antenna, this organ would closely resemble the representations of the young Iulus given by Newport; the surface of the whole antenna seems to be marked with very minute, irregular, raised points, not crowded together.

I ought here to speak of the remains referred doubtfully by Dawson to a labrum; they are situated next to the head, but are equal to it in size, and seem to be three or four connected segments of the abdomen of some orthopterous or neuropterous insect; their whole length is 2.15 mm., and they vary from 1.1 mm. to 1.45 mm. in breadth.

Mr. Henry Woodward, of the British Museum, in an article printed in the Transactions of the Geological Society of Glasgow,[2] has announced the first discovery in Great Britain of a species of *Xylobius;* having examined specimens from Kilmaurs, Ayrshire, and from Cooper's Bridge, near Huddersfield, he states that he does not "think the specimens of this fossil entitle us to consider it as specifically distinct from that discovered by Dr. Dawson, although a comparison of the figures may convey that impression." The illustrations of the English specimens given by Mr. Woodward differ so greatly from each other, that one would almost feel justified in believing they belonged to two distinct species; I would hardly hazard such an opinion without a comparison of the specimens themselves, yet I cannot believe that they belonged to any species I have had before me, unless the illustrations greatly misrepresent the comparative length and breadth of the segments; in these drawings the segments are half as long as broad; in the Acadian species they vary from a proportion of 1 to 3.05 to that of 1 to 5.574. I am convinced, both from this and from similar differences, that the British species — if there be only one — must be distinct from any of the American ones, and I therefore propose for it the name of *Xylobius Woodwardi*. That the English specimens belong to *Xylobius*, and not to *Archiulus*, is probable, for

[1] There may be more than one joint at this place, although one only can be seen.

[2] Vol. II, pt. iii, pp. 234–248.

Mr. Woodward states that "the segments are marked by alternate ridges and furrows, and the surface presents a somewhat rugose appearance, very different from the smooth and shining articuli of the recent Iulus," and again, "this shows the segments to have been ornamented with transverse, finely undulating lines." If the cross lines given in one of Mr. Woodward's figures are correctly rendered, and represent the frustra into which the segment is broken, we have an additional feature distinguishing the species, for these frustra are far longer and narrower than those of *X. sigillariæ* Daws., the most extreme of the American species in this particular; the engraver has of course rendered the legs inaccurately in making the tips furcate, since in all myriapods they are furnished with only a simple claw; the length of the legs is another point of distinction, if we are to judge from the plate, but as the description of these parts is so greatly at variance with the figures,[1] we will only draw attention to the necessity of examining this point more carefully. The British specimens seem to be much more perfect than any I have seen.

It seems fairly deducible from the above detailed descriptions, that these fossil myriapods compose a family of chilognaths, closely allied to the Iulidæ, but distinct from any now living, and to which the name of *Archiulidæ* may be applied. They may be characterized as having a cylindrical (or subcylindrical?) body of uniform size throughout the principal portion, but tapering, at either extremity, to about half the dimensions of the central portions of the body; they are composed of a large number of segments, not differing greatly in character from those of Iulidæ, and furnished with lateral pores of a large size from the seventh segment posteriorly; the legs are attached in double pairs to the anterior half of each segment posterior to the fourth, and are not known to be present on segments anterior to these; the head is destitute of eyes, or, if furnished with them, the ocellar tubercles are few in number, and rather distant from each other; the antennæ are composed of four (?) joints, very simple in structure. The genus *Xylobius* may be defined as an Archiulid, in which the segments — with the exception of those composing the head and anal plates — are broken by sutures into fragments which may be termed frustra, which run anteriorly and posteriorly across the segment; the segments themselves are either slightly and regularly convex, or ridged anteriorly. The genus *Archiulus* closely resembles *Xylobius*, but the segments are not broken into frustra, and, in the single species known, are prominently ridged on the anterior borders of the segment; the antennæ are divided into two nearly equal halves by a deep constriction between the second and third joints.

[1] The figure represents the legs as nearly twice as long as the width of the body, but the author states that the body is "two lines across the widest, and one line across the narrowest segment," and that the legs are "one line in length."

Supplementary Note on Fossil Myriapods.

When my paper upon these insects was published by this Society,[1] the drawings with which it was intended to accompany it were unfortunately mislaid. Having recently been found, and no further material having been discovered since they were drawn, I publish the figures for the assistance of any one endeavoring to study these very obscure remains. All the species described in the memoir referred to are illustrated here.

Fig. 1 represents two contiguous segments of *Xylobius sigillariæ*, showing the shape of the segments and frustra, with the position and form of the lateral pores and legs, those only of one side being shown; in this and the two subsequent figures the anterior end of the segment is at the right hand.

Fig. 2 shows corresponding segments of *Xylobius similis*, with the omission of the lateral pores and legs, these being unknown.

Fig. 3 gives the same parts of *Xylobius fractus*, with the legs and the lateral pores, the former of their supposed length.

Fig. 4 exhibits a single segment of *Xylobius Dawsoni*; here the division lines of the frustra are represented as strongly curved, only to exhibit the prominence of the anterior ridge; in this figure and the next, the anterior end of the segment is at the left hand; the slight divarication of the division lines of the frustra in this figure represents the appearance they present at the anterior extremity of the body.

Fig. 5 represents a similar segment of *Archiulus xylobioides*, showing its shape, the anterior ridge, the size and position of the lateral pores, and the length and position of the legs.

Fig. 6 is reduced from a camera sketch of *Archiulus xylobioides* to show the tapering of the anterior extremity of the body. The posterior segments of the specimen are greatly worn, and do not exhibit the anterior ridge; anteriorly the body is not very well preserved, and all the lines shown are not the division lines of segments; nor is the anterior segment a correct representation of the head; so that the figure answers only for the general outline.

Fig. 7 gives the antennal joints of *Archiulus xylobioides*, showing their close general resemblance to those of the larval antenna of recent myriapods.

[1] Memoirs, Vol. II, Part. II, No. III, On the Carboniferous Myriapods preserved in the Sigillarian Stumps of Nova Scotia.

The Early Types of Insects; or the Origin and Sequence of Insect Life in Palaeozoic Times.

In the year 1833, Audouin exhibited at a meeting of the Entomological Society of France the wing of an orthopterous insect from Coalbrook Dale in England.[1] This was the first discovery of insects in the coal-formation. Since then many authors, notably Germar and Goldenberg,[2] have added to our knowledge of the insects of the palaeozoic rocks, until now perhaps one hundred species are known. Yet insect remains in these strata may still be looked upon as the greatest rarities. By far the larger part of these hundred species are known to us by single specimens, and very fragmentary ones at that — a wing or even a mere piece of a wing being usually all that we know of a given form. It has been claimed by some writers that we should anticipate the earliest types of insects to be winged and not apterous, and the remains that have been found would seem at first glance to sustain such a hypothesis. But as the wings retain after inhumation more characteristic features than other parts of the body, it is not surprising that naturalists have made most use of them in describing the fossil forms; and we should scarcely be warranted in deducing therefrom the absence of other fragments of the body; moreover a characteristically apterous form of

[1] Ann. Soc. Ent. France, Vol. II, Bull., p. 7–8. It is also stated that the same specimen was exhibited by Audouin on Feb. 25, 1833, before the Académie des Sciences; but no report of the meeting was published, unless in *Le Temps* newspaper, which I have not seen. The insect was considered by Audouin as neuropterous, but has recently been shown by Swinton to be orthopterous.

[2] For Germar's writings on palaeozoic insects, see the following: — 1. Beschreibung einiger neuen fossilen Insecten. < Münst., Beitr. z. Petref., V: 79–94, pl. 9, 13. 4°. Bayreuth, 1842. — 2. Die Versteinerungen des Steinkohlengebirges von Wettin und Löbejün in Saalkreise. f°. Halle, 1844–53.

For those of Goldenberg, see the following: — 1. Prodrom einer Naturgeschichte der fossilen Insecten der Kohlenformation von Saarbrücken. < Sitzungsb. math.-nat. Cl. K. Akad. Wiss. Wien, IX: 38–39. 8°. Wien, 1852. (In this his name is given as Goldberger). — 2. Brief an Herrn v. Carnall. < Zeitschr. Deutsch. Geol. Gesselsch., IV: 246–48. 8°. Berlin, 1852. — 3. Ueber versteinerte Insectenreste in Steinkohlengebirge von Saarbrücken. < Amtl. Ber. Vers. Gesellsch. deutsch. Naturf., XXIX: 123–26. 4°. Wiesbaden, 1852. — 4. Die fossilen Insecten der Kohlenformation von Saarbrücken. < Palaeontogr., IV: 17–40, pl. 3–6. 4°. Cassel, 1854. — 5. Beiträge zur vorweltlichen Fauna des Steinkohlengebirges zu Saarbrücken (Uebersicht der Thierreste der Kohlenformation von Saarbrücken). < Jahresb. K. Gymn. u. Vorsch. Saarbr., 1867, 1–26. 4°. Saarbrücken, 1867. — 6. Zur Kenntniss der fossilen Insecten in der Steinkohlenformation. < Neues Jahrb. f. Mineral., 1869: 158–68, pl. 3. 8°. Stuttgart, 1869. — 7. Zwei neue Ostracoden und eine Blattina aus der Steinkohlenformation von Saarbrücken < Neues Jahrb. f. Mineral., 1870: 286–89 with figures in text. 8°. Stuttgart, 1870. — 8. Fauna Saraepontana fossilis. Die fossilen Thiere aus der Steinkohlenformation von Saarbrücken. Heft 1–2. 4°. Saarbrücken, 1873–77. (Heft 1 is the same as No. 5, above, with the addition of plates; a supplementary part is promised by Goldenberg.)

For other papers descriptive of the palaeozoic insects of Europe, see the writings of Andree, van Beneden and Coemans, Preudhomme de Borre, Brodie, Charles Brongniart, Buckland, Corda, Curtis, Dohrn, Fric, Geinitz, Giebel, Hagen, Heer, Jordan and Meyer, Kirkby, Mahr, Murchison, Roemer, Rost, Salter, Sternberg, Swinton, and Woodward; and for those of America, papers by Dana, Dawson, Harger, Lesquereux, Meek and Worthen, Scudder, and Smith.

cockroach[1] has been described from the rocks of Saarbrücken, which are as old as any of the insect-bearing beds of Europe. The insects of the middle Devonian of New Brunswick,[2] on the other hand, are known only by their wings and the most diligent examination of thousands of fragments of shale has failed to reveal anything else. Further discussion of this point may be dismissed with the remark that geological data are not likely to throw much light upon it.

It is of course of prime importance that we should understand the relative subordination of groups in insects, before investigating their order of succession in time. Many attempts have been made to harmonize the current views of their relative rank and geological succession; but hitherto with indifferent success, mainly from the prevalence of the opinion that Coleoptera were to be ranked highest among insects, while this suborder has been known, from the first, to occur in Carboniferous strata, and some other suborders only much later. Another obstacle which has stood in the way of a clear comprehension of the facts has been the very common division of hexapod insects into two series, upon which the English entomologists have perhaps specially insisted, called Mandibulata and Haustellata, a division based upon inadequate physiological grounds. Or if it be maintained that the function expressed in these names has a structural basis, it would be easy to point out that in either of the two divisions the diversity of structure of the mouth parts is so great as to admit of no common expression in other than physiological terms. If it were not so, the claim made by Agassiz,[3] on embryological grounds, of a higher rank for the haustellate insects would hold good, and we should be at a loss to account for the simultaneous appearance of Coleoptera and Hemiptera.

An apparently more rational division of the true insects into two series is that which separates those with complete from those with incomplete metamorphosis; the young in the former case unlike, in the latter resembling, the parent. This however, taken absolutely, separates closely allied groups, such as the caddice flies and dragon flies, and one form of metamorphosis shades into the other; moreover it allies the Coleoptera with the Hymenoptera rather than with the Hemiptera or Orthoptera, and disaccords to so great a degree with the general relations of structure among insects as to show that it cannot be considered as of so fundamental an importance as we should suppose it would prove. Yet it is an important factor in the life history of insects, and cannot be disregarded totally, as is done in divisions based upon the mouth parts, but must be considered in any attempted distribution of the suborders. So too must the nature of the wings, for the possession of wings is the preëminent characteristic of hexapods as a whole, and we should naturally anticipate fundamental features in the differences of their structure.

My own view of the primary relations of the suborders of hexapods was first expressed by Packard in 1863,[4] when he said that Coleoptera, Hemiptera, Orthoptera, and Neuroptera "seem bound together by affinities such as those that unite by themselves the bees, moths and flies." To the latter or higher series he has since applied[5] the term METABOLA

[1] (*Polyzosterites granosus.*) Goldenb., Faun. Sar. foss., 1: 18, pl. 1, fig. 17.

[2] These Devonian insects, which were first briefly noticed by me in Bailey's Observations on the Geology of Southern New Brunswick (8°. Fredericton, 1865) will form the subject of a special paper now nearly completed.

[3] L. Agassiz. Classif. ins. embryol. data. pp. 4–8.

[4] Packard. On synthetic types in insects. Bost. Journ. Nat. Hist., VII: 591–92.

[5] Packard. Guide to the study of Insects. Introduction. 8° Salem, 1869. In later editions these names are also introduced in the text, on p. 104, with varying spelling.

(in a more restricted sense than first used by Leach), and to the former, HETEROMETABOLA. The Metabola are unquestionably more homogeneous than the other group. One of their primary features is found in the more clearly marked regional divisions of the body; this is a consideration of great significance, since in the progress of structure, from the worms, through the crustaceans to the insects; or within the class of insects, from the myriapods, through the arachnids to the hexapods; or in the developmental history of the Metabola themselves, from the larva, through the pupa to the imago, we discover a constantly increasing concentration of the segments of which the body is composed into distinct regions, culminating in the Hymenoptera, where head, thorax and abdomen are most sharply defined. This feature was first insisted upon by Agassiz in his remarkable essay on the classification of insects (l.c., pp. 20–28), but its application to the division of the hexapods has not before been pointed out; yet a very little consideration will show how much more clearly these regions are marked in the Metabola than in the Heterometabola, especially if the separation of the thorax and abdomen is examined. This is indeed what we might, not unreasonably, look for in the highest members of a group characterized, as are the hexapods, by the possession of organs of flight: the greater development of these organs would necessitate a more compact and distinctive organization of the region devoted almost exclusively to them; and accordingly in the Metabola we have, on the one hand, a more highly organized thorax, more definitely separated from head and abdomen, than in the Heterometabola; and on the other hand, greater power of continuous flight, of poise, of rapid movement, of sudden and repeated change of direction, and a far greater grace of movement in the former than in the latter.[1] This specialization of the thorax led me at one time to think of proposing the term Sternoptena for the Metabola; and, in allusion to the general preponderance of the abdomen in the groups composing it, Gastroptena for the Heterometabola. For the latter series the term Gastroptena would be more distinctive, but the names suggested by Dr. Packard seem to me better adapted to general use, besides having the advantage of prior application, and I accordingly adopt them.

In addition to the primary features mentioned (which were not stated by Packard), the Metabola are characterized by a usually cylindrical body with a very small prothorax; mouth parts formed in whole or in part for sucking, the points of the mandibles seldom opposed to each other; front wings membranous and much larger than the hind wings, which latter are sometimes aborted; the larva cylindrical and very unlike the adult, and the pupa always inactive. The Heterometabola on the other hand usually have a flattened body, with a very large prothorax; mouth parts usually adapted for biting, the points of the mandibles then opposed to each other; front wings usually more or less coriaceous or with very numerous and thickened veins, and usually smaller than the hind wings, which latter are only exceptionally aborted, and never throughout large groups; the larva is usually flattened, often resembling the adult, and the pupa either active or inactive.

[1] This we affirm only as a general rule, taking each suborder as a whole. There are, it is true, apterous or subapterous Hymenoptera, bungling and inert fliers among the Lepidoptera, and Diptera which have a heavy and direct flight; and on the other hand, groups like the Odonata among Neuroptera, whose rapidity and power of sudden change of flight is very striking; but these do not affect the characters of suborders as wholes; and in the exceptions which might be noticed, the specialization of flight is nearly always accompanied to a certain degree by a corresponding development and distinctiveness of the thorax.

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The exceptions in the former group are only in the Hymenoptera, which usually have mandibles well developed for opposing each other. In the latter, more heterogeneous group, the exceptions are more abundant. In the Coleoptera the metamorphosis is complete.[1] In the Hemiptera, the mandibles are developed as needles and with the other parts of the mouth form a sucking tube; in many of them also the front wings are almost wholly membranous. The Neuroptera, using the term in the Linnaean sense, are the least amenable to law; their fore wings are usually membranous, though the veins are generally thick and approximated; a few (Ephemerina) have small hind wings; many of them show the regional divisions of the body almost as strikingly as the Metabola, although the abdomen is generally developed to an excessive extent, and in such insects the prothorax is not greatly developed; while, as before stated, part of them have an incomplete metamorphosis, and so have been classed with the Orthoptera by the later German writers, and others have an incomplete metamorphosis. The structural affinities, however, of the Neuroptera proper and the so-called Pseudoneuroptera are so close that they cannot be disconnected, notwithstanding the striking differences in general features between them; and although, thus composed, the Heterometabola exhibit anomalous features in nearly every suborder contained in it, we must accord to this division of hexapods into Metabola and Heterometabola a closer connection with all the facts than any that has yet been proposed.

How closely this division accords with the geological succession of insects will appear from the fact that all the suborders of Heterometabola, and none of Metabola are represented in the palaeozoic rocks.[2] This is the more striking from the fact that, if we omit mention of the single discovery of insect wings in the Devonian, the three orders of insects, — hexapods, arachnids and myriapods, appear simultaneously in Carboniferous strata.[3]

[1] It would appear, at first sight, as if Dr. LeConte, in his Classification of the Coleoptera of North America (8°. Washington, 1861), Introduction, p. 8, held that Coleoptera were to be ranked as the highest suborder among hexapods. His table would seem to indicate this; but he speaks with hesitation, as if proposing only a provisional arrangment, remarking: "We can merely state in general terms that those [hexapods] having a perfect metamorphosis are the highest; and those having the thoracic segments agglutinated, or the prothorax separate, are to be considered above those in which the larval character of similarity among the thoracic segments is preserved." To the first proposition no one will take exception; the latter ought to be restricted in its application to those groups only to which the Coleoptera are most nearly related, viz.: to the other Heterometabola; so far as they are concerned this would seem to be an indication of special and therefore comparatively high structure; but otherwise, as a mark of inferior organization, since it is opposed to the progress of structure seen throughout the articulates, marked by a condensation, so to speak, of the thoracic segments. Many Neuroptera and Orthoptera, notably such forms as Corydalis and Forficula (the latter classed by early writers with Coleoptera), show in their prothorax a close resemblance to Coleoptera; and the very size and importance of this segment in Coleoptera, when the whole hexapod series is taken into account, should therefore be looked upon as a sign of relatively low rank. I am pleased to be able to state, from a recent conversation on this point with Dr. LeConte, that he did not intend to extend the argument drawn from the prothorax over the whole hexapod series, but only over those most nearly related to Coleoptera, and purposely expressed himself in guarded language.

[2] No generalization so broad as this and at the same time correct has yet been made. Many authors indeed, and notably Bronn, dividing the hexapods into two series,—Mandibulata and Suctoria (or equivalent terms) — claim that the carboniferous hexapods were all biting insects, and that the sucking insects first appeared in the Jura. The latest statement of this sort was made by Haeckel (Gen. Morph. Organ., II, p. xcix, 1866), but Dohrn's Eugereon was published in the same year, and by the light of this strange insect many palaeozoic insects now appear, as I shall endeavor to show below, under an entirely new aspect, and render it probable that there were many, as there certainly were some, sucking insects in palaeozoic times.

[3] Carboniferous arachnids have been described by Corda, Fric, Harger, Meek and Worthen, Roemer, Scudder, and Woodward; while myriapods from the same formation have been described by Dawson, Meek and Worthen, Scudder, and Woodward; besides others from other palaeozoic beds by Dohrn and Geinitz.

The earliest known Diptera occur in the Liassic rocks at Cheltenham, Dumbleton and Forthampton in England; the Lepidoptera[1] in the middle Oolite (Solenhofen); and the Hymenoptera in the same formation.[2] The Metabola are then later in time and more perfect in development than the Heterometabola.

When we analyze the insect fauna of the earliest times more closely, we notice that the higher suborders of Heterometabola, the Coleoptera and Hemiptera, are represented in the palaeozoic rocks by very few types, as compared with the Orthoptera and Neuroptera; the two former groups having but three or four each,[3] while Goldenberg enumerates fifteen or sixteen of each of the others from Saarbrücken alone, and double that number must be known. No Coleoptera nor Hemiptera have yet been found in the palaeozoic formations of America, while I am acquainted with about forty Orthoptera and Neuroptera from these rocks. The almost entire absence of Coleoptera from palaeozoic rocks is the more remarkable, because their crust is much thicker than that of other insects, and their shards as hard as the shell of the body. This is peculiarly the case in the lowest and presumably oldest type, the weevils or Curculionidae. Their remains have been preserved with the greatest readiness in more modern strata; in fact, in all the newer rocks, Coleoptera are best represented of all insects; yet in the oldest, very few have been found in comparison with the remains of the lower suborders. This is a striking and indisputable fact, and notwithstanding the paucity of the material whereon to base a general statement, is scarcely to be explained on any other hypothesis than that of the later appearance of Coleoptera.

In the Orthoptera again, nearly all the families represented belong to the lower series; only four or five members of the saltatorial families have been found, the cockroaches of the Carboniferous period outnumbering all the other Orthoptera many times. In the last catalogue of fossil cockroaches (by Goldenberg), thirty-five species are recorded from the Carboniferous rocks and only seven from the Tertiary formation. Indeed about one-half the known species of palaeozoic insects are cockroaches.

Or, if we look at the Neuroptera, we find that the Neuroptera proper, or those with complete metamorphosis, scarcely occur at all in the palaeozoic rocks; whereas the lower Pseudoneuroptera, with incomplete metamorphosis, are comparatively abundant. Many of the reticulate-winged insects of early periods, however, combine the characters either of the Neuroptera and Orthoptera, or of the Neuroptera proper and Pseudoneuroptera. So striking, indeed, is the comprehensive nature of these early types that Dohrn, and after him

[1] The carboniferous Breyeria of de Borre (Comptes rend. Soc. Ent. Belg., [2.] XIII: 7–11) is universally conceded to be a neuropterous insect. See the remarks in the same journal by Hagen, Heer, McLachlan, de Selys, Scudder, Van Volxem and others.

[2] A single species, doubtfully referred by Heer to the latter suborder, has, however, been found in the Lias of Schümbelen.

[3] The only Coleoptera known to me are *Curculioides Ansticii* Buckl., from Coalbrook Dale, *Trozites Germari* Goldenb., from Altenwald, and the borings of a *Hylesinus* described by Brongniart as occurring in petrified wood from the carboniferous limestones of Autun. Geinitz also describes borings of a larger beetle in fossil wood from the Saxon coal measures to which Frič gives the name of *Xyloryctes planus*; and Sternberg others from Bohemia of a doubtful character, which Frič calls *Xyl. septarius*. *Curc. Prestvicii* Buckl. has been shown to be an Arachnid.

The only Hemiptera from these lowest rocks are *Fulgora Ebersi* Dohrn and *Fulgorina Klieveri* Goldenb., from Saarbrücken, and *Macrophlebium Hollebeni* Goldenb., from Kanebach; besides *Fulgorina lebachensis* Goldenb., from the Permian. *Eugereon Boeckingi* Dohrn, cannot be classed here, as will appear further on.

Goldenberg, proposes to group them under a new subordinal division, to which Goldenberg has applied the name Palaeodictyoptera.[1]

This view I am inclined to think a correct one, but no definition of the group has yet been attempted; and while, on the one hand, Goldenberg appears to have gone too far in referring to it the Carboniferous insects from Illinois described by Dana, and the Devonian insects of New Brunswick, it would seem probable that Woodward's Archimantis[2] should be classed therein, as well as the genera Eugereon, Dictyoneura, Paolia and Haplophlebium; and it is by no means improbable that they all possessed mouth parts structurally comparable to the remarkable Eugereon of Dohrn, which certainly can be referred to no existing group of insects. When more of their structure is known, they will probably be found to agree in the possession of a remarkably depressed, cockroach-like body, with ample thoracic segments, the prothorax well separated from the other joints, broadly expanded or extended, reticulated wings, lancet-shaped mandibles and maxillae, long labial palpi which have no direct part in the haustellate structure of the mouth, and multiarticulate antennæ. This is a combination quite at variance with that of any group of recent or of newer geological times, and indeed is known to us only in the palaeozoic rocks. It forms a synthetic type in the largest sense, and may be said to combine features of all the Heterometabola.

But it was not the only such type then existing; for, as has already been noted, there are many other palaeozoic insects which combine in their structure features now characteristic of diverse groups. Such are nearly all the Devonian insects. It is also not a little remarkable to find that recent types existed in the earliest periods side by side with these. Some of the Devonian insects, for example, are to be referred with very little question, not only to the Neuroptera, but even to a particular family of Neuroptera now existing, the May flies. Indeed, the presence, at the apparition of a given group, of modern types, side by side with those which elude our classification of existing forms, is one of the peculiar problems of palaeontology.

Perhaps no more striking instance of this can be found than the recent discovery by M. Charles Brongniart, in the upper Carboniferous rocks of Commentry, of one of the most specialized forms of insects which exist; of a type indeed so modern, that, so far as I may judge from a rough sketch sent me by Brongniart, one would not have been surprised to meet with its exact counterpart in every detail, living in the tropics of the old world. It is a species of large, spinous, thick-bodied Phasma or walking-stick, with abbreviated tegmina, long wings and body, rather long and slender legs and antennæ, and in all its parts

[1] Cf. Dohrn, Palaeontogr., XIII: 338-39; XIV: 134. Goldenberg, Faun. Sar. foss., II: 8. Dohrn first proposed the term Dictyoptera, but afterwards withdrew it, as preoccupied.

[2] Woodward. On a remarkable orthopterous insect from the coal-measures of Scotland. < Quart. Journ. Geol. Soc. Lond., 1876: 60–64, pl. 9. Woodward, it seems to me, has in all probability mistaken the affinities of this insect. If his figure is placed beside Dohrn's first illustration of Eugereon, the similarity of the two will be apparent. The form and relations of the head, prothorax and broadly expanded wings (nearly all that is preserved in Archimantis) are the same in each, as well as, in a general sense, the neuration of the wings. The projection in front of the head, therefore, would seem to be, not a prolongation of the head itself, comparable, as supposed by Woodward, to that of the head of some living Mantidæ; but a rostrum, like that of Eugereon, though much shorter than it, and by its state of preservation apparently amalgamated with it into a single mass; or, it may be the labrum alone with the other parts removed, for it would then probably appear as an integral part of the head. The close relationship of the wing-structure in Archimantis, Eugereon and the other genera specified above render it not improbable that they were all sucking insects. Protophasma however, similarly related, certainly was not.

perfectly reproducing the customary and yet unique features of the Phasmida of to-day.[1] The family had not previously been known earlier than the Tertiaries.

We may glean still another fact from the scanty data the rocks afford us concerning the early types of insects. All the Hemiptera of the palaeozoic rocks belong to the Homopterous division of the suborder; indicating, what is generally conceded, that this division is lower than the Heteroptera, which first appeared in the Jura.[2] Now one conspicuous difference between these two divisions is found in the structure of the base of the front wings, which is coriaceous in the Heteroptera and membranous in the Homoptera; showing that differentiation of the front and hind wings is, as we should suppose it might be, a later development, the homogeneous condition preceding it. Among Orthoptera, none of the families, unless it be the walking-sticks, have more densely coriaceous fore-wings than the earwigs and the cockroaches. The earwigs first appeared in the Oolite; and while cockroaches were abundant from the earliest times, it is not, with one exception, until we reach the Lias that we find species with close approximation and multiplication of the veins of the front wings, giving them a coriaceous appearance. This exception, *Ledrophora Girardi*,[3] in which the veins are nearly obsolete, occurs in the Trias; and it is the earliest indication of any differentiation of the front and hind wings in cockroaches; for all the palaeozoic species had tegmina which were as distinctly veined as the wings, and could not, in any sense, be called coriaceous.[4] The same distinctness of the veins is apparent in all the other palaeozoic Orthoptera; so that, excepting the two species of Carboniferous Coleoptera and Protophasma (which do not appear to differ in this respect from living types), we may say that the wings of palaeozoic insects were homogeneous.

Inasmuch as we know the earliest insects principally from the remains of their wings, it is interesting to note in them a further striking fact. If we should formulate the charac-

[1] Since the above was written, I have received from M. Brongniart his final memoir on Protophasma (Note sur un nouveau genre d' Orthoptère fossile de la famille des Phasmiens — Ann. Sci. Nat., [6] VII, Art. 4), by which it appears that the wings must be excepted from the statement given above; for they differ remarkably from the wings of living Phasmida, and resemble extraordinarily the wings of Palaeodictyoptera, and especially those of Dictyoneura. They could not have been folded longitudinally to the degree that the wings of Phasmida are now plaited, for the anal area embraces less than one-third of the wings, and the interspaces between the veins of that part of the wing which lies above the anal area, are not straight but curved; in the number and arrangement of the veins in this upper part of the wing we have an almost exact counterpart of the wings of Dictyoneura; the same, to a less extent, may be said of the wings of the Fulgorina described by Goldenberg. This type of wing structure was therefore a very common one among palaeozoic insects, and accounts for Brongniart's suggestion, hardly to be received, that these Fulgorina should be considered Neuropterous; indeed the neuration of the wings of the numerous carboniferous Blattariæ does not lack a somewhat close adherence to the same type, and we may yet succeed in establishing an unusual degree of homogeneity in the wing structure of all or nearly all palaeozoic insects.

[2] Perhaps a similar statement may be made even of the few Coleoptera known. For, if we accept LeConte's primary division of Coleoptera into normal and rhyncophorous, the former the higher, and look upon the Troxites of Goldenberg, as I strongly incline to do, as a curculionid, — the only indication of the higher normal Coleoptera in the palaeozoic rocks will be the borings brought to notice by Geinitz, which were evidently made by a longicorn, a family of normal Coleoptera ranking rather low in the series.

[3] Heer. Ueber die fossilen Kakerlaken. < Vierteljahrschr. naturf. Gesellsch. Zürich, IX : 297, pl., fig. 5. 8°. Zürich, 1864.

[4] Exception should perhaps be made to the very remarkable cockroach described by Goldenberg (Faun. Sar. foss., I : 17, pl. 2, fig. 14, 14a), under the name of *Blattina insignis*; this insect has a slender, perhaps cylindrical, abdomen with tegmina and wings which appear to be equally leathery and in which nearly all trace of veins are lost. Here, however, all the wings appear to be alike in form, consistency and structure; and Goldenberg has given us only a meagre account of it, which is the more unfortunate, since it is second in interest only to Eugereon and Protophasma.

teristics of the wing structure of living insects (which show, indeed, a variety of type truly marvellous, and ranging from exceeding simplicity to a complexity which nearly baffles all attempts at homology), we should not need to modify our statement in the least particular to include the wing-structure of the insects of earliest times. The plan of neuration upon which the wings of insects were then constructed is the plan we find in all existing types. At the same time, as stated above in a note, there was an unusual degree of homogeneity in the wings of palaeozoic insects.

This review clearly indicates that the laws of succession of the insect tribes are quite similar to those which have long been known to hold in other groups of the animal kingdom; and that the facts are, in the main, such as the theory of descent demands. The exceptions to theory, however, and indeed the general facts, are such as to indicate that profound voids exist in our knowledge of the earliest history of insects. The appearance of hexapods in the middle Devonian long previous to any traces either of myriapods or of arachnids; the apparent advent of generalized groups of a comparatively narrow range, before those which are wider in scope and embrace the former; the apparition of Coleoptera, which present no indication of any divergence from the subordinal type, in Carboniferous beds first yielding an abundance of insect remains,— that is, as early as any insects whatever, excepting the homogeneous-winged Heterometabola of the Devonian; and the occasional discovery of highly specialized types at very early periods: — all point to the far earlier existence of widely comprehensive types, from which all these comparatively specialized but still more or less synthetic forms must have originated. The additions to our knowledge of palaeozoic insects within the past twenty years, and the increasing indications of dry land at earlier and earlier epochs,[1] must leave little doubt in the reflecting mind, not only that insects existed in no scanty numbers in Devonian and even in Silurian times, but that persistent research over wider fields will probably enable us, at no distant day, to replace hypotheses with facts.

In conclusion, we may recapitulate, as follows: —

1. With the exception of the few wings of hexapods known from the Devonian, the three orders of insects — hexapods, arachnids and myriapods — appeared simultaneously in Carboniferous strata.

2. Hexapod insects may be divided into a higher group (Metabola), including Hymenoptera, Lepidoptera and Diptera; and a lower group (Heterometabola), including Coleoptera, Hemiptera, Orthoptera and Neuroptera.

3. All Devonian and Carboniferous insects are Heterometabola, the Metabola making their first appearance in the Jurassic period.

4. Many synthetic or comprehensive types existed in palaeozoic times, combining the characters either of all the Heterometabola; of Orthoptera and Neuroptera; or of Neuroptera proper and Pseudoneuroptera.

5. The Devonian insects either belong to comprehensive types related to the two lower suborders only, or are low Pseudoneuroptera; and were undoubtedly aquatic in early life.

6. The lower suborders of Heterometabola,— Orthoptera and Neuroptera, were much more abundant in palaeozoic times than the higher,— Coleoptera and Hemiptera.

[1] Cf. Lesquereux. Land plants, recently discovered in the silurian rocks of the United States. < Proc. Amer. Philos. Soc., XVII: 163–73, pl. 4. 8°. Philadelphia, 1877. On the first page of this paper will be found a résumé of our knowledge of this subject.

7. Nearly all the palaeozoic Orthoptera belong to the lower non-saltatorial families, and are almost exclusively cockroaches.

8. The Neuroptera proper were at that time much rarer than the lower Pseudoneuroptera.

9. All the earlier types were therefore of inferior organization.

10. The general type of wing structure in insects has remained unaltered from the earliest times.

11. With the exception of two species of Coleoptera and one of Orthoptera, the front and hind wings of palaeozoic insects were similar and membranous, heterogeneity making its appearance in mesozoic times. At the same time, the neuration of the wings of palaeozoic insects in otherwise widely diverse types was much more similar than now.

12. The series of facts presented to us by the progress of geological research leads to the conviction of the probable existence and possible discovery, in the Devonian and even in the Silurian formations, of winged insects, still more generalized in structure than any yet detected in the palaeozoic rocks.

It may also be added that nearly all the earlier insects were large, many of them gigantic in size, and, further, that there is a striking similarity between the carboniferous insect-fauna of Europe and North America.

NOTE. The preceding pages were printed before I chanced upon the following passage from Lacordaire (Introd. à l'entom. I, p. 326), which may be taken as a note to the last paragraph of third page of this paper: —

"Toutes les différences que l'on observe dans le thorax des Insectes proviennent du plus ou moins de développement qu'a pris chaque anneau thoracique, du nombre de pièces que chacun d'eux présente, et de la grandeur relative de chacune de ces pièces en particulier. Si le prothorax a acquis un développement extraordinaire, et s'est en quelque sorte séparé du mésothorax et du métathorax, on aura le thorax d'un Coléoptère, d'un Dermaptère, d'un Orthoptère et d'un Hémiptère. Si au contraire le prothorax est réduit à des dimensions très-exiguës, et que le mésothorax intimement uni au métathorax ait pris un accroissement énorme, on aura celui d'un Hyménoptère, d'un Lépidoptère et d'un Diptère."

Palaeozoic Cockroaches: A complete Revision of the Species of Both Worlds, with an Essay toward their Classification.

THE study of fossil insects has hitherto furnished very little material toward a knowledge of the general laws which have governed the progress of animal life. The reason of this is not far to seek. The delicate nature of their framework is such that they are never found preserved in any abundance, and seldom in such condition as to preclude doubts as to their affinities; the number of extinct known forms bears, indeed, a very small proportion to that of other fossils. Moreover, the most important period in the history of any group of animals is its earliest; and while the later appearance of mammals, creatures possessing a bulky framework less liable to destruction, enables the naturalist to reconstruct what must be a very significant part of the primitive mammalian faunas, the very early appearance of insects, with their fragile framework, is a serious obstacle to obtaining any light whatever concerning their origin. Fragment by fragment have the few facts been patiently gleaned; yet to-day we possess for the entire palaeozoic period not more than one species of insect to every thousand existing forms.[1] A few scattered generalizations concerning these earlier insects have been attempted, and in the preceding paper I endeavored to collect all that was known upon the subject, and to show that some general statements might be made, not likely to be gainsaid by further facts. The present paper discusses with greater fulness the cockroaches of the palaeozoic period, a group which contains fully one half the species of insects known from the ancient rocks, and therefore one most likely to be fruitful in results.

Their remains were first made known by Germar[2] in 1842, in Count Münster's Beiträge zur Petrafactenkunde, where four species from Wettin were described and figured. Soon afterwards, in his general work on the fossils of Wettin and Löbejün, Germar redescribed these with as many more; and additional forms have been published from time to time by Goldenberg, Heer, E. Geinitz and others, until the number of European species at present recognized in the palaeozoic rocks is about forty. To find the original descriptions of these forty species one must look for no less than sixteen different papers by seven different writers; rarely, too, have any of them received any further study after their original description; it necessarily follows that our knowledge of them is very fragmentary, and a worse showing could be made were we to include the American species, of which descriptions of seven have appeared on six separate occasions.

[1] Compare this with the ratio of fossil to living mammals, as seen in the list given in Murray's Geographical Distribution of Mammals, pp. 320–64. 4°. London, 1866.

[2] One species had been previously described, but as a fern leaf.

It is true that some slight suggestions have been made toward the classification of these insects, but, as will be shown further on, without much success. With rare exceptions all have been described under the generic term Blattina; the species, however, have occasionally been confounded, and their relationship to one another and to the cockroaches of later times has never been seriously examined. This examination seems the more desirable for two reasons. First; as a general rule, it is the upper wing of these creatures which has been preserved, allowing the best comparison not only with their living representatives, but with one another; for, owing to the transparency of the front as well as hind wings of palaeozoic insects, the venation is remarkably distinct, and from the nature of the part preserved is rarely displaced in fossilization. Second; our opportunities for any generalizations concerning palaeozoic insects are exceedingly limited; and this group, as the most abundant of all the ancient types, offers the most inviting field of research. It would appear, too, that the known species are in reality only the fragment of a vast host which existed at that time, but have left no further traces, a host so great as to render it suitable to characterize the carboniferous epoch, so far as insects are concerned, as the age of cockroaches.

This conclusion is drawn from two facts. Every new discovery of palaeozoic cockroaches, with scarcely an exception, reveals new species, so that upwards of sixty different kinds are enumerated in this paper, showing great diversity of structure, and seldom represented by more than a single specimen; this indicates that their petrifaction is a rare event, and that the few relics we have really represent a vast horde. The second fact is the decreasing representation of these insects in the rocks as we approach the present time, coupled with a very generous allowance of cockroaches living at the present day. If we divide the time which has elapsed since cockroaches appeared into three great divisions, corresponding to the palaeozoic, mesozoic and caenozoic epochs, embracing the present period in the last-named, we shall have, say, sixty species in the palaeozoic, thirty-five in the mesozoic and only sixteen fossil species in the caenozoic (even including those occurring in that most prolific insect-trap, the Prussian amber), with upwards of five hundred living species.[1] If we then consider the present as a part of the pliocene, and take only five hundred species as the number actually living in each of the three divisions of caenozoic time, making fifteen hundred in all, and sixteen as the number now reported as existing in tertiary times; and, finally, assume the same ratio between the unknown and the known to have held in the palaeozoic as in the caenozoic epoch, we shall have five thousand, six hundred and twenty-five species as the number of palaeozoic cockroaches. Even if enormously exaggerated, this estimate will at least indicate the prodigious quantity of cockroaches which then existed and give an additional reason for the present revision.[2]

Giebel, who published the first list of palaeozoic cockroaches, then supposed to be only eight in number,[3] brought them all under the generic term Blattina, and placed with them also some of the mesozoic species. In a foot-note (p. 315) he promises to give a "careful revision" of all the Wettin cockroaches, but this he has never done.

Heer, in his catalogue of fossil cockroaches,[4] was the first to attempt any division of the palaeozoic forms; his classification was as follows:—

[1] This is certainly a low estimate of existing types. Brunner in 1875 enumerated nearly four hundred species, and since that time enormous additions to this family have been made, particularly by de Saussure.

[2] Perhaps we may fairly add that the early appearance and prevalence of cockroaches also explains in a measure the cosmopolitan distribution and vexatious fecundity — the domination in short — of certain existing species of cockroach.

[3] Giebel. Die Insecten und Spinnen der Vorwelt. 8°. Leipzig, 1856. pp. 313–16.

[4] Heer. Vierteljahrschr. naturf. Gesellsch. Zurich. Jahrg. IX, pp. 287 *et seq.* (1864.)

Div. a. Reticulation tetragonal; main veins free. (9 species.)
Div. b. Main veins connected at the base. (1 species.)
Div. c. Reticulation polygonal; main veins free. (2 species.)
Div. d. Hind wings. (2 species; one wrongly placed here.)

The only other classification which has been attempted is that recently made by Goldenberg,[1] which is merely an extension of Heer's. He first separates those of the true carboniferous series from those occurring in the dyas, and for the former offers the following scheme:

- Winged;
  - fore-wings membranous with distinct venation;
    - principal veins free;
      - with simple quadrangular cells arranged in rows; . . . . . Group I. (11 sp.)
      - with polygonal cells; Group II. (18 sp.)
    - principal veins connected at the base; Group III. (1 sp.)
  - fore wings coriaceous, with indistinct venation; . . . . . Group IV. (1 sp.)
- Wingless; . . . . . Group V. (1 sp.)

The few species from the dyas are divided into that from Weissig (1 sp.), and those from Lebach (2 sp.), and the latter are placed severally in groups corresponding exactly to Groups II. and III. of the carboniferous series.

Nearly all the species represented by fore-wings, whether in the classification of Heer or of Goldenberg are grouped, then, according to whether the minute cross-venation or reticulation of the wings is composed of polygonal cells or simply of cross veins running directly from one nervule to another. There are three serious objections to the naturalness of such a classification. First, it assigns a high importance to a necessarily insignificant feature in the structure of the wing. Second, the reticulation is frequently invisible either from its actual absence or the imperfect preservation of the fossil. And third, the same wing exhibits, certainly in some American species (e. g. *Etobl. venusta*, *E. Lesquereuxii*), a transverse reticulation in one part of the wing, and a honeycombed reticulation in another. We may therefore fairly set aside these classifications as insufficient and unsatisfactory.

More than ten years ago, in studying the first fossil cockroaches that came under my observation, and noticing the diversity of structure in the wings of palaeozoic species, I described two types under new generic names; but on the discovery and separate description of additional forms, it seemed best to revert to the common custom of referring all to Blattina until the present revision or some other was attempted.[2] A considerable number of new and interesting forms having recently accumulated, it seemed a favorable opportunity to pass the entire series under review; accordingly the illustrations of the described European species were copied and brought, as given in the plates, to the same scale (× 2 diam.), and, when necessary, so reversed as to place the costal margin on the left, the base of the wing being uppermost. This renders comparison more direct and simple, and in such as have been reversed it is merely the same as if one looked at the wing from the opposite surface.

A comparison of these with American types at once showed that, among the latter at least, a remarkable degree of diversity obtained, necessitating the division of the palaeozoic cockroaches into two tribes, according to the structure of the uppermost vein of the front wing: this vein, in one tribe, exclusively American, being composed of a series of long

[1] Goldenberg. Fauna saraepontana fossilis. Heft 2, pp. 18–20. 4°. Saarbrücken, 1877.

[2] Canad. Naturalist (2) VII, 271.

and unequal rays spreading from a common base, much like the rods of a fan; while in the other, found on both continents, the shorter and equal rays originate at regular intervals, as branches from the side of a main vein. No such important distinction exists in the cockroaches of the old world coal-measures, even in the most aberrant types; but within each of these two tribes, other distinctions appear, in the relative extent or position of the different areas, in the mode of branching of the main veins, or in the point of origin of the branches, affording valuable data for generic distinctions, and a tolerably safe clue, it is believed, to the true relationship of the species.

The classification proposed in this paper, based upon the structure of the framework of the wing, and generally neglecting its mere form or surface sculpture, may be expressed briefly by the scheme on the opposite page, which will be more fully developed in the body of the memoir.

A word may be said concerning the nomenclature employed in this scheme. It will be noticed that the generic term Blattina, first employed for palaeozoic cockroaches by Germar and since universally adopted in the same sense, has been dropped. It is not a little curious that the first four species described by Germar (and, I may add, the first American palaeozoic cockroach, described by Lesquereux) all belong to a single genus as here defined, namely Etoblattina, a genus at the same time the richest in species; so that there can be no doubt whatever as to which of these genera should bear the old name, if any of them can do so. It were indeed to be wished that it might be retained by Etoblattina, and to preserve the old name as far as possible I have retained it as a part of all the compound terms I have employed to designate the genera represented in the European carboniferous fauna, as well as in the tribal name which embraces them. But before Germar made this use of the term Blattina, earlier indeed by about thirty years,[1] he applied it to a cockroach from amber, which must be employed as the typical species, and which is utterly distinct from any of the palaeozoic forms. We are therefore unwillingly compelled to reject the name for palaeozoic cockroaches, and, unless indeed it be a synonym of some earlier name, to employ it for the tertiary Blattarian only.[2]

The use of the term Palaeoblattariae for all the palaeozoic cockroaches to distinguish them from more modern types requires also an explanation. In commencing this investigation it was anticipated that the mode of distribution of the principal veins of the wing and the relative area occupied by each would furnish some ground for discussing the affinities and natural classification of these animals and of separating them into genera and species. But the degree of divergence from living types which the palaeozoic forms exhibit, and their own division into two large groups was entirely unexpected. To appreciate the former distinctions, it will be best first to examine the wings of living Blattariae.

The structure of the organs of flight in cockroaches has received an unusual share of attention, principally from Messrs. Brunner and de Saussure, who have devoted a great

[1] Germar. Mag. d. Entom. Jahrg. I, 16 (1813).

[2] In his first use of the term Blattina, Germar employed it without any explanation whatever. In his work on Wettin fossils (p. 81), he says: "Blattinae nomine utimur, quo omnes species complectimur, quae antehac ad Blattae genus sunt relatae." Goldenberg (Palaeontogr. IV, 5) was the first to define the genus, as follows: "Venis omnibus areae analis hemelytri in marginem internum excurrentibus." In it he placed *Etobl. primaeva*, *Hermatobl. labachensis* and *Petrabl. gracilis*. Goldenberg (*loc. cit.*) further credits Berendt with the first use of the term, but I cannot discover that Berendt used it either in 1830 or in 1836, the two occasions when he referred specially to fossil cockroaches; while Germar certainly employed it in 1813. Nor did Berendt use it in 1845 in the essay prefixed to his Organische Reste im Bernstein.

PALAEOBLATTARIAE.

Tribe I. *Mylacridae.* Branches of the mediastinal vein arranged in a radiate manner, mostly springing from a common point at the base of the wing; mediastinal area subtriangular, uniformly tapering apically. (3 genera. American.)

All the branches of the mediastinal vein arising close to the base of the wing.

- Wings broad. Mediastinal and scapular areas together occupying less than half the wing. Externomedian area tolerably large, expanding regularly beyond the first branch. **Mylacris.** (5 species).
- Wings slender. Mediastinal and scapular areas together occupying more than half the wing. Externomedian area small and compressed, scarcely expanding apically. **Lithomylacris.** (3 species.)

Some of the apical branches of the mediastinal vein arising beyond the base of the wing and scarcely partaking in the radiate arrangement of the others. **Necymylacris.** (2 species.)

Tribe II. *Blattinariae.* Branches of the mediastinal vein arising at regular intervals from a principal stem; mediastinal area generally band-shaped. (8 genera. Both worlds.)

Externomedian vein terminating beyond, rarely at, the middle of the outer half of the wing. Scapular and externomedian areas together covering less than one half of the wing.

Mediastinal area comparatively short, rarely exceeding, seldom equalling two-thirds the length of the wing.

- Scapular area not reaching the tip of the wing, the extremity of the main vein curving upward. Externomedian area comparatively large. **Etoblattina.** (20 species. Both worlds.)
- Scapular area extending beyond and embracing the tip of the wing, by the backward sweep of the main vein. Externomedian area comparatively small. **Archimylacris.** (2 species. American.)

Mediastinal area long, usually at least three-fourths the length of the wing, sometimes nearly reaching the tip.

Branches of scapular vein superior.

- Externomedian branches inferior, so that the nervules divaricate on either side of the scapular-externomedian interspace. **Anthracoblattina.** (7 species. European.)
- Externomedian branches superior, so that the nervules divaricate on either side of the externomedian-internomedian interspace. **Gerablattina.** (12 species. Both worlds.)

Branches of scapular vein inferior. **Hermatoblattina.** (2 species. European.)

Externomedian vein terminating before the middle of the outer half of the wing. Scapular and externomedian areas together covering more than half the wing.

Externomedian vein directed toward and terminating near the apex of the wing, its branches inferior.

- Principal veins closely crowded in the basal half of the wing. Branches uniformly distributed all over the wing. Scapular area terminating above the apex of the wing. **Progonoblattina.** (2 species. European.)
- Principal veins widely separated in the basal half of the wing. Branches much more closely crowded in some parts of the wing than in others. Scapular area terminating below the apex of the wing. **Oryctoblattina.** (1 species. European.)

Externomedian vein directed toward and terminating near the middle of the inner border of the wing, its branches superior. **Petrablattina.** (2 species. Both worlds.)

deal of study to this family,[1] and having used the tegmina and wings for systematic purposes, have examined an immense series of specimens. These authors distinguish in the tegmina four, in the wings five, principal veins, the distribution of which is pretty constant in their general features, variable in the details; and this permits excellent characters to be drawn for the separation of the genera, etc. The four veins of the tegmina are the mediastinal, the scapular, the internomedian and the anal.[2] The mediastinal vein runs from the root of the wing in a nearly straight course to about the middle of the costal border, throwing off branches to that border. The scapular vein extends to the tip of the wing in a nearly straight course and throws off toward the costal border a number of branches, which may be simple or forked and disposed with greater or less regularity; in some instances, especially toward the tip of the wing, it also throws out branches on the opposite side. The anal furrow is an impressed curved line, characteristic of cockroaches, running to the inner margin before the middle of the wing; within the area thus marked off at the base of the wing are a number of simple or forked anal nervules, often curved, but always straighter than the anal furrow; these, although they impinge upon the latter, are to be considered branches of the anal vein, for they correspond to the radiate nervules of the longitudinally plicate portion of the hind wings. Between the scapular and anal veins runs the internomedian vein, an irregular nervure, the branches of which may be inferior or superior, longitudinal or oblique, simple or forked, and it is here therefore that the greatest variation in the manner of distribution occurs, although the relative extent of all the fields may greatly vary.

The hind wings have two features which are different from what we find in the tegmina; the first is the great expansion of the anal area, the innermost nervule of which is not developed as a furrow; the second is the presence of a new and distinct vein, the externomedian, lying between the scapular and the internomedian. There is no doubt that in the tegmina this vein should be regarded as amalgamated with the scapular vein, and the branches occasionally found near the apex of the tegmina, parting from the so-called scapular vein and terminating on the inner or apical margin (e. g., Chorisoneura), as the branches of the externomedian vein; the more so since in some genera (Ectobia, etc.) the internomedian vein is also amalgamated with the scapular, so that the so-called scapular vein appears to throw branches indifferently to one side or the other of the wing.

This curtailment or disappearance of the externomedian vein is due according to Saussure to the contraction of the tegmina. In comparing the tegmina with the wings, he remarks:[3] "La portion de l'organe [i. e. the tegmina] située en arrière de la nervure humérale [scapular vein] s'est tellement contractée que le champ anal a pénétré dans le champ discoïdal [internomedian area] et se trouve un peu enveloppé par celui-ci. En y pénétrant, il l'a étranglé à la base, en refoulant la veine discoïdale [internomedian vein] contre la nervure humérale [scapular vein], en sorte que ces deux nervures se confondent à la base; et il s'est rétréci lui-même. Dans cette contraction, l'aire vitrée [externomedian area] a disparu." We should be careful however not to give Saussure's words a meaning they were not intended to convey; the broadly expanded plicated area of the hind wings

[1] Brunner. Nouveau Système des Blattaires. 8°. Vienne, 1865, pp. 4–12. — Saussure. Etudes sur l'aile des Orthoptères < Ann. Sc. Nat. [5] Zool., x, pp. 161, *seq.*; — *Ib.*, Orthoptères de l'Amérique moyenne. 4°. Genève, 1864. pp. 16–28. — *Ib.*, Miss. Scient. au Mexique, Ins. Orth. 4°. Paris, 1870, pp. 4–8.

[2] This is Heer's terminology, not Brunner's nor Saussure's.

[3] Ann. Sc. Nat. [5] Zool., x, p. 196.

is with little doubt a comparatively late development, and we may not look upon the tegmina as a contracted form of the wings; but rather, at the disappearance of the externomedian vein in the tegmina as one stage in the increasing heterogeneity of the organs of flight, as we pass from ancient times to the present; indeed the hind wings of insects in general contain far more indications of the earlier structure and ornamentation of the wings than the front pair.[1] As one example of this we find that the externomedian vein was perfectly developed in the front wings of all the palaeozoic cockroaches, and although probably some of the different nervures were sometimes blended at the base (e.g., *Etoblatt. russoma*, *Petrabl. gracilis*), apically each vein was always developed quite separate from the others.

This is a distinction of prime importance, and so far as we can discover, there is not a single exception in ancient or modern types. In all the palaeozoic species, the externomedian exists as an independent vein; in all modern species the vein itself is blended with the scapular, and can only be occasionally recognized near the extremity by its branches.

Besides this difference there is another which, although of less importance, is perhaps as constant and certainly is significant. In palaeozoic cockroaches the anal veins of the fore wing, as first noted by Goldenberg, impinge upon the border, just as they do in the few hind wings which are preserved. In living cockroaches, the branches of the anal vein in the hind wing, preserving here again the ancient characteristics, impinge upon the margin of the wing; while the specialization of the anal area of the fore wing—a distinctively Blattarian feature—has gone so far as to affect the direction of the veins, which do not impinge upon the border, but run parallel to it and strike the anal furrow.

For these reasons, as being of fundamental importance in the structure of the tegmina, and indicative of the profound changes the entire group of cockroaches has undergone since its origination, it appears necessary to separate the palaeozoic cockroaches from those existing at the present day as a distinct subfamily type.

In reviewing the existing species, in order to obtain some clue among them to the nearest allies of the palaeozoic cockroaches, it would appear that very little resemblance exists between the fore wings of the ancient species and those of the *Blattariae spinosae*, as compared with those of the *Blattariae muticae*. Further than this it would perhaps hardly be possible to go, unless indeed we were to compare some of the Blaberidae of the present day, comprising the giants of the time, with some of the ancient types, which, while generally larger than recent forms, also often boast of their very great size. Unfortunately we know almost nothing of the structure of the legs in the ancient cockroaches; they have been preserved, so far as appears, in only one or two instances. In one, *Blattina Tischbeini*, Goldenberg speaks of a fragment of a hind leg, consisting of the femur and tibia with traces of spines (*Spuren von Dornen*); but as neither his illustration nor his description show whether the spines occur on the femora or on the tibiae, we have no proof as to whether the former should be considered *spinosae* or *muticae*. In the illustration of the other (*Anthracobl. sopita*) no spines appear; and the describer of this species, Dr. E. Geinitz, gives no further account of the legs than their size; perhaps their preservation allows of no further statement, but this point should be studied.

[1] This point, which I hope to expand and illustrate on another occasion, is what might well be expected when we reflect how commonly the hind wings of insects are concealed by the front pair, when the insect is at rest.

Let us now examine the neuration of the wings of cockroaches with special reference to its development, in order to determine which of the two tribes into which we have divided the Palaeoblattariae is to be considered the more primitive type. At the outset we may remark that were we to base our ideas of the relative rank of the existing suborders of insects upon the degree of complication of the neuration of their wings alone we should undoubtedly fall into error. Yet, although in studying the most ancient insects this portion of their structure is nearly all we have to guide us, we may confidently assume that it is here sufficient to determine their relationship with accuracy. The variation in the structure of the wings of existing insects is the result of a multitude of forces exerted through aeons, and exhibits every imaginable form from extreme simplicity to excessive complexity: in some insects the wings, like the rest of the body, have retained an ancient simplicity of structure, as in the May-flies; in others they appear to have lapsed into simplicity, or to have retained a simple distribution of the veins, when the other parts of the body have become highly organized, such as the Lepidoptera generally; in still others, by the diversity of use to which the wings have been put, they have become in different ways extremely complicated, so that the plan of neuration is greatly disturbed or nearly lost; as in the hind wings of earwigs, and of many cockroaches and beetles, and in both wings of dragon flies, — nearly all of which insects are otherwise lowly organized.

This differentiation of the neuration, we may judge by many proofs,[1] had made slight progress in palaeozoic times. The wings of the then existing insects were comparatively simple and uniform. Nevertheless, the variation of structure was already sufficient in the carboniferous epoch to prove that we must look far back of it for the origin of winged insects. We have already shown that differences existed among cockroaches warranting their division into two great groups; and as a whole this family group was distinctly separated, even at that early time, from all other insects, even as they are to-day, unless we except their nearest allies the Mantidae, in the burial of the innermost anal vein at the bottom of a deep sulcation, dividing the anal area from the rest of the wing. They were also peculiar — although a few ancient types partially shared with them this characteristic — in that the large number of mediastinal branches, as well as the main mediastinal vein, terminate on the costal margin only, and do not leave it simply supported by the main vein lying in close proximity. This peculiarity necessitated a somewhat central origin for the veins at the base of the wing, and apparently led to the diversity noticed in the two types of ancient cockroaches.

If we were to express in simplest terms the structure of a symmetrically developed wing (like that of the palaeozoic cockroaches with its five principal branching veins), we should figure the middle vein as running straight to the apex, forking as it went and occupying the apical margin with its branches; while the similarly forking branches of the upper two veins would curve toward and terminate upon the costal margin, and those of the lower veins upon the inner margin. A wing has already been found[2] quite as simple in idea as this, but belonging to the other group of palaeozoic insects, in which the wing is not symmetrical, but where all the veins and their branches impinge upon the inner and apical margin of the wing. In such a wing, differentiation of the veins may scarcely be said to

[1] See the preceding paper: The early types of insects.

[2] Scudder. An insect wing of extreme simplicity from the coal formation. <Proc. Bost. Soc. Nat., Hist. XIX, 248–49.

exist; the second repeats the first, and the fourth the fifth, a little further removed from the base, while the third vein, filling the space between the second and fourth, differs from them only by its straightness and apical termination; the general resemblance of each to the others is very close. Yet one has scarcely more to do than to deepen the inner anal vein, and perhaps remove the main veins a little nearer the costal border, giving a very slight asymmetry to the wing, to impress upon such an ideal wing distinct blattarian features; for in all the palaeozoic cockroaches, partially excepting Oryctoblattina, the distribution of the scapular branches more or less resembles that of the mediastinal, and that of the internomedian the anal, while the externomedian branches occupy the middle ground and the apex of the wing, seldom swerving to either side.

It is, however, highly probable that such an ancient wing was broad at the base, for this was the case with nearly all the palaeozoic insects, and certainly, which is more to our purpose, with all the carboniferous cockroaches; it is furthermore a characteristic of the cockroaches of the present day, and therefore all the more probably of high antiquity. In this case the mediastinal and anal areas must have been more broadly triangular in shape than the neighboring areas, and their veins consequently arranged in a more radiate fashion, the different branches arising close together from a common base; while in the neighboring areas they would naturally arise at intervals from a main stem. This condition is precisely that of the Mylacridae and would naturally precede that in which the mediastinal vein, to strengthen the part of the wing most liable to strain, follows the basal curve of the costal margin and throws its branches off at intervals toward the border, heightening at the same time the resemblance between the distribution of the branches in the scapular and mediastinal areas; a tendency to this appears in Necymylacris and it is fully developed in the Blattinariae. That the anal vein has not followed the same rule is doubtless due, partly to the small need of special support for the lower base of the wing, and partly to the deep impression of the inner anal vein, which has forced, as it were, the other branches to ally themselves with it.

This view of the relative primitiveness of the two types of ancient cockroaches is strengthened by noticing the further differentiation of the tegmina in modern times, where the only remaining relic of repetition of characters in adjoining areas is the resemblance of the disposition of the scapular and mediastinal branches; and even this resemblance recalls the features of the Blattinariae, rather than of the Mylacridae. In all the Palaeoblattinariae, so far as we know them, (excepting perhaps in Oryctoblattina,) the internomedian veins have the same general tendency to repeat the downward and outward curve of the anal veins as we find in the corresponding veins of the costal region. But in recent cockroaches, not only do the anal veins run parallel to the inner margin and impinge upon the anal furrow, but the internomedian veins may branch in any direction, so varied has the plan of distribution grown; in general however the internomedian vein may be said to have assumed in modern types the rôle played by the externomedian vein in the Palaeoblattariae; and in not a few instances in the ancient types there is a marked tendency of both the scapular and internomedian veins, especially toward the apex of the wing, to assume a mode of distribution more closely resembling that of the externomedian than of the mediastinal and anal branches respectively. Indeed the similiarity of the distribution of the veins in the scapular and externomedian areas has induced me to place Hermatoblattina

and Progonoblattina near Oryctoblattina high in the series. Petrablattina has also been placed very high, on account of the apparent amalgamation of all the principal veins next the base, as they generally appear in modern types.

On zoological grounds, then, we should look upon the Mylacridae as the older type, but when we come to examine the geological record, we discover very little special correspondence between these features of structure and the relative age of the insects in question. Our oldest American species are *Gerablattina fascigera* and *Petrablattina sepulta*, and probably *Blattina venusta*, all of which are Blattinariae, not Mylacridae; the other American members of the group of Blattinariae are found in all the rocks up to the permo-carboniferous, while the Mylacridae are confined to the true coal-measures, unless *Necym. heros* and *Archim. parallelum* fall below them. On the other hand, it is worthy of remark that of the nine species placed highest in the entire series below, before their stratigraphical position was at all considered, and belonging to five distinct genera, *Petrablattina gracilis*, *Hermatoblattina lebachensis* and perhaps *Gerablattina balteata* belong to the permian or dyassic formation, and comprise nearly one half of the species certainly known from that horizon. And it will be seen further on that much the largest percentage of the European cockroaches (Blattinariae only) come from the upper carboniferous beds; of the American (Mylacridae and Blattinariae) from below them. It must not be overlooked however that the great mass of palaeozoic cockroaches as a whole come from the highest carboniferous rocks, and that the stragglers that have been found below these uppermost beds are far too few for us to base any safe generalizations upon them.

As to the geological range of the species, it would appear as if it were always extremely limited, did we not reflect that very few of the species are known by more than one example. It has been claimed by Dr. E. Geinitz that five of the species first described from the carboniferous series, viz.: *Etobl. anthracophila*, *Etobl. carbonaria* and *Etobl. didyma* of Wettin, *Anthracobl. spectabilis* of Löbejün, and *Gerabl. Mahri* of Manebach, all from the uppermost carboniferous rocks, were also found in the lower dyas of Weissig. He supports his statement by figures or descriptions in three instances, and in each of these cases I shall show that the reference was incorrect: *Etobl. didyma* being referred below to a distinct species, *Anthracobl. sopita*; *Etobl. anthracophila* to *Etobl. flabellata*; and *Gerabl. Mahri* to a second distinct species, *Etobl. elongata*. This result throws some doubt upon the unsupported references in the two other cases, and while these remain in doubt,[1] *Etoblattina flabellata* is the only species unquestionably found in both the carboniferous and dyassic series of the old world. The only other European species said to have been found at two distinct localities is *Etobl. didyma*, which Germar described from Wettin and Mahr says has been repeatedly found at Ilmenau; but these places are at the same horizon.

In the new world the only instance of the discovery of a second specimen of any species is in the presumed case of *Gerablattina balteata*, where one was found in what are termed permo-carboniferous rocks, on account of some question as to their true horizon, and the other in undoubted uppermost carboniferous rocks. The so-called permo-carboniferous rocks, however, are deemed by some geologists as certainly upper carboniferous.

[1] Geinitz himself refers to *Anthrac. spectabilis* with a query.

Few of the genera appear to be confined to very narrow geological limits excepting those which are poor in species. Mylacris (5 sp.) however is only found in the lower or middle carboniferous series, as is also Necymylacris (2 sp.) and Archymylacris (2 sp.). Gerablattina (12 sp.), Progonoblattina (2 sp.) and Oryctoblattina (1 sp.) are the only European genera not occurring in the dyas and the first of these occurs in the permo-carboniferous of America; but Anthracoblattina (7 sp.), though occurring throughout the range of cockroaches in the European palaeozoic rocks, has its largest development (5-6 sp.) either in the dyas or in the very highest of the upper carboniferous beds.

The following table represents the cockroach fauna of the different localities in the palaeozoic beds of Europe, the two doubtful species of Weissig being placed in brackets.

DYAS.

Weissig, Saxony.

Etoblattina flabellata.
" weissigensis.
[" carbonaria.]
[Anthracoblattina spectabilis.]
" sopita.
" porrecta.

Lebach, near Saarbrücken, Rhenish provinces of Prussia.

Hermatoblattina lebachensis.
Petrablattina gracilis.

Rockheim, Bavaria.

Anthracoblattina Rückerti.

CARBONIFEROUS.

Saarbrücken (immediate vicinity), Rhenish provinces of Prussia.

Etoblattina primaeva.
" labachensis.
" insignis.
Anthracoblattina winteriana.
Gerablattina intermedia.
" scaberata.
Hermatoblattina wemmetsweileriensis.

Saarbrücken (basin).

Anthracoblattina Remigii (Cusel, Rhenish Bavaria).
Gerablattina weissiana (Brücken, Waldmohr, Rhenish Bavaria).

Manebach, near Ilmenau, Saxe Weimar.

Etoblattina didyma.
" manebachensis.
Gerablattina Goldenbergi.
Gerablattina clathrata.
" Mahri.
Progonoblattina Fritschii.

Wettin-Löbejün, Prussian Saxony.

Etoblattina euglyptica.
" affinis.
" flabellata.
" anthracophila.
" Dohrnii.
" anaglyptica.
" carbonaria.
" didyma.
Etoblattina russoma.
" leptophlebica.
" parvula.
Anthracoblattina spectabilis.
Gerablattina Geinitzi.
" Münsteri.
" producta.
" Germari.
Oryctoblattina reticulata.

Klein-Opitz, near Dresden, Saxony.

Anthracoblattina dresdensis.

Erbignon, Switzerland.

Progonoblattina helvetica.

Durham, England.

Etoblattina mantidioides.

The following table, mainly based on the "Chronologische Uebersicht des Steinkohlen-Ablagerungen in Europa", given by Dr. H. B. Geinitz in Geinitz, Fleck u. Hartig: Die Steinkohlen Deutschlands, 4°, München, 1865, may serve to indicate the probable relative age of the European species. The carboniferous beds are divided by him into five zones, as follows, commencing at the base: I. Hauptzone der Lycopodiaceen; II. der Sigillarien; III. der Calamiten; IV. der Annularien; V. der Farren. The two dyassic species enclosed in brackets are those credited by Dr. E. Geinitz to this formation. Perhaps all the carboniferous species should be classed together as upper carboniferous, excepting the three placed under zone II-III; and these to the middle carboniferous.

LOWER DYAS.

Etoblattina flabellata. (Weissig.)	Anthracoblattina sopita. (Weissig.)
" weissigensis.(")	" porrecta. (")
[" carbonaria.] (")	" Rückerti. (Stockheim.)
" elongata. (")	Hermatoblattina lebachensis. (Lebach.)
[Anthracoblattina spectabilis.] (Weissig.)	Petrablattina gracilis. (")

CARBONIFEROUS ZONE V.

Etoblattina didyma. (Manebach.)	Gerablattina Goldenbergi. (Manebach.)
" manebachensis. (")	" clathrata. (")
Anthracoblattina dresdensis.(Klein-Opitz.)	" Mahri. (")
" Remigii. (Cusel.)	" weissiana. (Brücken.)
Progonoblattina Fritschii. (Manebach.)	

UPPER CARBONIFEROUS?

CARBONIFEROUS ZONE IV–V.

Etoblattina primaeva. (Auerswald.)	Etoblattina leptophlebica. (Löbejün.)
" labachensis. (Labach.)	" parvula. (")
" euglyptica. (Wettin.)	Anthracoblattina spectabilis. (")
" affinis. (Löbejün.)	Gerablattina intermedia. (Wemmetsweiler.)
" flabellata. (Wettin.)	" Geinitzi. (Löbejün.)
" anthracophila. (")	" Münsteri. (Wettin.)
" Dohrnii. (")	" producta. (")
" anagliptica. (")	" Germari. (")
" carbonaria. (")	Hermatoblattina wemmetsweileriensis.
" didyma. (Wettin.)	(Wemmetsweiler.)
" russoma. (Löbejün.)	Oryctoblattina reticulata. (Wettin.)

CARBONIFEROUS ZONE II–V.

Etoblattina mantidioides. (Durham.)	Progonoblattina helvetica. (Erbignon.)

MIDDLE CARB.?

CARBONIFEROUS ZONE II–III.

Etoblattina insignis. (Saarbrücken.)	Anthracoblattina winteriana. (Dudweiler.)
Gerablattina scaberata. (Altenwald.)	

The American species come from the following localities, the Mylacridae being placed in the left hand, the Blattinariae in the right hand column.

ACADIAN COAL-FIELD.

Sydney, Cape Breton.
Mylacris bretonense. — Petrablattina sepulta.
" Heeri.

Pictou, Nova Scotia.
— Archymylacris acadicum.

APPALACHIAN COAL-FIELD.

Cannelton, Beaver Co., Penn.
Mylacris pennsylvanicum. — Archymylacris parallelum.
" Mansfieldi.
Necymylacris heros.

Pittston, Luzerne Co., Penn.[1]
Lithomylacris angustum. — Etoblattina Lesquereuxii.
" pittstonianum. — Gerablattina fascigera.
Necymylacris lacoanum.

Cassville, W. Virginia.
— Gerablattina balteata.

Bellaire, Ohio.
— Gerablattina balteata.

EASTERN INTERIOR COAL-FIELD.

Danville, Ill.
Lithomylacris simplex.

Colchester, Ill.
Mylacris anthracophilum.

WESTERN INTERIOR COAL-FIELD.

Frog Bayou, Arkansas.
— Etoblattina venusta.

The correlation of the beds in the Eastern border and Interior basins of N. America is not yet satisfactorily accomplished. The period of the deposition of the millstone grit in the interior basin may even possibly be synchronous, I am informed by Professor N. S.

[1] Concerning the localities in the vicinity of Pittston, Mr. E. D. Lacoe, to whom I am indebted for all the specimens described from there, writes me that the shale containing *Etoblattina Lesquereuxii* was picked up in the vicinity of Pittston, in a pile of culm or impurities from a mine; the exact locality was unknown to him, but from the character of the slate he had no doubt of its being from the roof shales of the D seam of anthracite coal. *Lithomylacris angustum* and *L. pittstonianum* are from the roof shales of the E seam of coal, which when unaffected by weathering much resemble the shales of the D seam, but is very rarely so highly impregnated with carbon. The specimens came from Port Griffith at the outcrop of the shales at one of the principal anticlinals that cross the otherwise quite level coal field, and once apparently formed long narrow islands in the carboniferous lake, against the southeastern side of which many small objects drifted and left their impress. *Gerablattina fascigera* was found by Mr. Lacoe in the anticlinal next north of the one first mentioned and also on the southeastern side. *Necymylacis lacoanum* comes from the lowes productive coal measures near Pittston.

Shaler, with some of the later coal deposits of the eastern border region; but assuming the millstone grit of the east and west to be of the same age, we may express tolerably well the general stratigraphical relations of the species by the following table:

		Base of Millstone grit.	*Top of Millstone grit.*	*Lower or Middle Coal Measures.*	*Upper Coal Measures.*	*Permo-carboniferous.*
MYLACRIDAE.	Appalachian coal-field.		Necymylacris heros.	Mylacris pennsylvanicum. Mylacris Mansfieldii. Necymylacris lacoanum.	Lithomylacris pittstonianum. Lithomylacris angustum.	
	Acadian coal-field.			Mylacris Heeri. Mylacris bretonense.		
	Eastern interior coal-field.			Mylacris anthracophilum. Lithomylacris simplex.		
BLATTINARIAE.	Appalachian coal-field.		Archimylacris parallelum. Gerablattina fascigera.		Etoblattina Lesquereuxii. Gerablattina baltea.	Gerablattina baltea.
	Acadian coal-field.		Petrablattina sepulta.	Archimylacris acadicum.		
	Western interior coal-field.	Etoblattina venusta.				

If we assume the separation between the upper and middle carboniferous to be correct, we shall have the following percentage of the species from the different formations in either country:

In Europe: Above the upper carboniferous 26 per cent.; in it 74 per cent.; below it 7 per cent.
In America: Above the upper carboniferous 6 per cent.; in it 24 per cent.; below it 76 per cent.

Certain species appearing in the lists twice over make the totals of percentage in each case above 100. It would appear from this summary that the American cockroaches are the older, and a certain light is thus thrown upon the occurrence of Mylacridae in the New World only.

I have already given some reasons for believing, not only that cockroaches formed the majority of insects in palaeozoic times, but that the actual number of species was very great. That they were also abundant in individuals is probable, judging from the present fecundity of their descendants and from a few other facts. Goldenberg, for instance, remarks (Faun. Saraep. foss. I, 17) that where one finds any remains of cockroaches in the palaeozoic rocks, one nearly always discovers more than a single fragment; at least this was the case with *Etoblattina primaeva*, *E. labachensis* and *Blattina Tischbeini*; and he judges from this, that, as at the present time, these creatures collected in numbers in a single spot; but it seems rather to indicate merely the great numbers of individuals which then existed. Goldenberg elsewhere remarks (Faun. Saraep. foss. II, 21) that cockroaches formed nearly one-half the insects of the coal period, reaching then their greatest development. He finds reasons for this, first, in the warmth and obscurity of the forest vegetation of that time, which only suited such animals as these; and second, in the intimate corre-

lation between the insect world and the plant world, by which the former finds its principal nourishment in the latter. Such a food-plant for the palaeozoic cockroach he would discover in the tree-like Noeggerathia, or the Cordaites of the period; just as the ally of the former, the sago palm, furnishes food to the cockroaches of to-day. Heer also relates, in his essay on fossil cockroaches, that the botanical garden at Zurich accidentally imported from Cuba cockroaches in all stages of development in stems of Cycads, and thereupon suggests that Noeggerathia might very probably have been the food of palaeozoic cockroaches. I have also described a species of Platyzosteria (*P. sabalianus*) which lives in the tops of the cabbage palmetto, *Sabal palmetto*. We thus arrive at some indications of the manner of life of these ancient creatures.

Heer believes the scantiness of our knowledge of fossil cockroaches to be due to the slight attention that has been paid to them, and that in the mass of plants which have been exhumed from the coal beds, many more will be found when these have been carefully examined with this in view. At the time he wrote not a single species of cockroach had been found in more than one spot (and at Wettin and Manebach they formed almost or quite the only insects found there) while many species of plants were common to the different beds from which cockroaches had been exhumed. Notwithstanding the considerable increase of our knowledge since that time, this is almost as true now as then.

In this paper we have discussed almost exclusively the front wings of the palaeozoic cockroaches. In an appendix, however, those species which have been described from other fragments are reviewed and the descriptions put into an English dress. These species are *Blattina Tischbeini*, *Bl. latinervis* and *Bl. venosa*, described from hind wings or very imperfect remnants of fore wings; and *Polyzosterites granosus*, a wingless species. *Acridites carbonaria*, first described by Germar as the wing of a saltatorial orthopteron and subsequently considered by him as the hind wing of a cockroach, possibly of *Etobl. didyma*, and so catalogued up to the present time, appears rather to be a neuropterous wing and therefore is not discussed here. Besides these a couple of obscure fragments from the American rocks are briefly noticed but without name. It only remains to give an alphabetical list of the former and present names of palaeozoic cockroaches, and the bibliography of the subject, before taking up the species in detail.

Synonymical Table of hitherto described Palaeozoic Cockroaches.

Archimylacris acadicum Scudd. = Archimylacris acadicum.
Blattidium mantidioides Gold. = Etoblattina mantidioides.
Blattina affinis Gold. = Etoblattina affinis.
Blattina anaglyptica Germ. = Etoblattina anaglyptica.
Blattina anaglyptica var. labachensis Gold. = Etoblattina labachensis.
Blattina anthracophila Germ. = Etoblattina anthracophila.
Blattina anthracophila Gein. = Etoblattina flabellata.
Blattina bretonensis Scudd. = Mylacris bretonense.
Blattina carbonaria Germ. = Etoblattina carbonaria.
Blattina clathrata Heer. = Gerablattina clathrata.
Blattina didyma Germ. = Etoblattina didyma.
Blattina didyma Gein. = Anthracoblattina sopita.
Blattina dresdensis Gein.-Deichm. = Anthracoblattina dresdensis.
Blattina euglyptica Germ. = Etoblattina euglyptica.
Blattina euglyptica Gold. fig. 8. = Etoblattina Dohrnii.
Blattina euglyptica Gold. fig. 9. = Gerablattina producta.
Blattina euglyptica var. weissiana Gold. = Gerablattina weissiana.
Blattina fascigera Scudd. = Gerablattina fascigera.
Blattina flabellata Germ. (Münst). = Etoblattina flabellata.
Blattina flabellata Germ. (Wettin). = Gerablattina Münsteri.
Blattina Fritschii Heer. = Progonoblattina Fritschii.
Blattina Geinitzi Gold. = Gerablattina Geinitzi.
Blattina Germari (Giebel) Heer. = Gerablattina Germari.
Blattina Goldenbergi Mahr. = Gerablattina Goldenbergi.
Blattina gracilis Gold. = Petrablattina gracilis.
Blattina Heeri Scudd. = Mylacris Heeri.
Blattina helvetica Heer. = Progonoblattina helvetica.
Blattina insignis Gold. = Etoblattina insignis.
Blattina intermedia Gold. = Gerablattina intermedia.
Blattina labachensis Gold. = Etoblattina labachensis.

Blattina latinervis Heer. = Blattina latinervis (hind wing).
Blattina lebachensis Gold. = Hermatoblattina lebachensis.
Blattina leptophlebica Gold. = Etoblattina leptophlebica.
Blattina Mahri Gold. = Gerablattina Mahri.
Blattina Mahri Gein. = Etoblattina elongata.
Blattina manebachensis Gold. = Etoblattina manebachensis.
Blattina parvula Gold. = Etoblattina parvula.
Blattina porrecta Gein. = Anthracoblattina porrecta.
Blattina primaeva Gold. = Etoblattina primaeva.
Blattina Remigii Dohrn. = Anthracoblattina Remigii.
Blattina reticulata Germ. = Oryctoblattina reticulata.
Blattina Rückerti Gold. = Anthracoblattina Rückerti.
Blattina russoma Gold. = Etoblattina russoma.
Blattina scaberata Gold. = Gerablattina scaberata.
Blattina sepulta Scudd. = Petrablattina sepulta.
Blattina spectabilis Gold. = Anthracoblattina spectabilis.
Blattina Tischbeini Gold. = Blattina Tischbeini (fragment).
Blattina venosa Gold. = Blattina venosa (fragment).
Blattina venusta Lesq. = Etoblattina venusta.
Blattina weissiana Gold. = Gerablattina weissiana.
Blattina weissigensis Gein. = Etoblattina weissigensis.
Blattina wemmetsweileriensis Gold. = Hermatoblattina wemmetsweileriensis.
Blattina winteriana Gold. = Anthracoblattina winteriana.
Mylacris anthracophilum Scudd. = Mylacris anthracophilum.
Polyzosterites granosus (Gold.) Jord. = Polyzosterites granosus (body).

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PALAEOBLATTARIAE.

Palaeozoic cockroaches; in which the fore wings are diaphanous, generally reticulated and nearly symmetrical on either side of a longitudinal middle line; the externomedian vein is completely developed and divides in the outer half of the wing, its branches generally occupying the apical margin. The internomedian area is broad at its base (beyond the anal area), rapidly tapers apically and is filled with oblique, mostly parallel veins, having nearly the same direction as the anal veins, which, like them, strike the inner margin.

Their bodies appear to have been flat, but slenderer than usual in cockroaches of the present day, the pronotal shield depressed, more or less elliptical, but sometimes longer than broad, the head partly concealed by it as in living types. They were of large size; but while the average was considerably above that of existing cockroaches[1] none were much larger than some S. American species of Blabera. Germar was the first to note the diaphaneity of the fore wings,[2] and Goldenberg the presence of the externomedian vein,[3] and the course of the anal branches.[4]

Mylacridae.

In this group the mediastinal vein of the tegmina with its branches consists of a number of veins, simple or forked close to their origin, spreading in a fan shape and appearing to arise from a single point or near a single point close to the base of the wing; or in other words, the branches originate from the main vein close to its base and to each other, the outermost being much longer than the innermost, often double as long as it, and either straight or uniformly arcuate; the area of the vein is thus triangular and more or less than half as long as the wing. The character of the vein therefore much more nearly resembles that of the anal vein than of the others. The group is confined, geographically, to America, and the wings are a little stouter on the average than those of the Blattinariae, the breadth being usually contained in the length less than two and one half times.

Mylacris (*μυλαχρίς*).

Mylacris Scudd., in Worth, Geol. Surv. Ill. III,, 568-69 (1868).

The mediastinal vein of the upper wing consists of about five principal stems, two or three of which fork before the middle, all of them straight or very gently curved, the outermost extending half way or even more to the tip of the wing; the point from which the principal stems originate is either in the middle of the wing or nearer its inner than its costal margin. The scapular vein is always arched strongly at the base before branching, which it commences to do as soon as allowed by the branches of the mediastinal vein; it then runs subparallel to the costal margin always to the extreme tip of the wing; during the larger part at least of its course it runs very nearly along the middle line of the wing,

[1] The average length of the front wing appears to have been about 26 mm.

[2] Der deutliche Aderverlauf, den wir . . . wahrnehmen, zeigt uns daher, dass diese vorweltlichen Arten pergamentartige Oberflügel besassen. Germar, Verst. Steink. Wettin, 82.

[3] Bei jenen [lebenden Blatten] lässt sich in diesem Felde nur eine sich stark verästelnde Mittelader wahrnehmen, während die Kohlenblatten hier zwei Mitteladern zeigen . . . wodurch das Mittelfeld in eine äusseres und ein inneres Mittelfeld getheilt wird. Goldenberg, Palaeontogr. IV, 20–21.

[4] Bei den Blatten der Jetzwelt münden die Adern dieses Hinterfeldes [anal field] theilweise in die Begreuzungsader [anal furrow] desselben, während bei den Lias- und Kohlenblatten sämmtliche Adern dieses Feldes in den Nahtrand [inner margin] auslaufen. Goldenberg, Palaeontogr. IV, 20.

so that the area of this vein generally occupies half the breadth of the wing, and together with the branches of the mediastinal vein, half of the whole area of the wing; it emits four or five branches, some of which fork, occasionally twice, and all of which run parallel or very nearly parallel to the outer branch of the mediastinal vein; to gain the apex and to keep this parallelism the terminal part of the scapular vein curves gently upward. The externomedian vein seldom forks before the middle of the wing and rarely occupies much space, generally branching but three times at the most, although one or more of these branches may have secondary forks; generally these branches are so straight that it is difficult to say whether they are superior or inferior to the main vein, but they appear to be indifferently one or the other. The internomedian and anal veins divide between them very equally the inner margin of the wing, the anal furrow being distinct, generally curved considerably and, from the great breadth of the wing, having its general course very oblique; the internomedian vein generally has but three or four branches, but several of these usually fork close to the base, the branches redividing, so that rarely less than nine or ten branches of this vein strike the margin, the first offshoot of the penultimate branch often having several inferior veinlets; the vein begins to branch at nearly the same point as the scapular vein, and occupies a subtriangular area with its spreading branches. The branches of the anal vein are in general more longitudinal than those of the internomedian vein, are nearly parallel, often forked and rather regular and abundant, but in one species are irregular and connected by cross branches.

The wings are peculiar for their unusual breadth at base and, so far as known, their tapering apex, produced mostly by the costal curve; the greatest breadth lies before the middle of the wing, and their length is hardly more than double their width, in which particular they differ greatly from Lithomylacris. They have a form common in recent Blattariae, such as Nyctibora, strongly tapering posteriorly, with convex anterior and posterior margins.

This genus differs principally from Lithomylacris by the form of the wing and by the obliquity of the anal furrow of the same; and from Necymylacris by the much greater breadth and longitudinal extent of the areas covered by the mediastinal and scapular veins, accompanied by a corresponding diminution of the extent of the externomedian area. The species are all of a rather small or moderate size and are found only in the new world.

The only fragment apart from front wings which has been discovered is a pronotal shield, presumably belonging to one of these species. It is shaped much as in the modern Periplaneta.

Mylacris bretonense. Pl. 5. fig. 1.

Blattina bretonensis Scudd., Can. Nat., VII, 271–72, fig. 1. Figured also in Dawson's Acadian Geology, Suppl. to 2d ed., p. 55, fig. 5.

The front wing has a pretty regularly tapering ovate outline, with a slightly produced but rounded tip; the costal margin is apparently regularly and considerably convex, especially near the base, and at least the middle third of the inner margin is straight, while the apical third of the wing tapers about equally from both sides. The veins appear to originate from a point scarcely above the middle line of the wing, and together to be directed considerably upward at base, following the strongly arcuate basal curve of the

costal margin nearly across the basal fifth of the wing. The mediastinal area is exceptionally small for this genus, even if we consider, as is probable, a marginal half to be destroyed; the veins in the fragment of it are somewhat obscure, consisting of only two or three parallel to each other, the lower or inner forking twice near the base and terminating a little before the middle of the wing. The scapular vein suddenly bends at the end of the basal fifth of the wing and runs closely parallel to the costal margin for a distance equal to about half the length of the wing, and then curves somewhat rapidly to a longitudinal direction, running down the middle line of the wing and terminating at its tip; its first vein, which like most of the others is deeply and simply forked, continues the direction of the basal part of the stem; the last is a shoot which parts from the main stem at about the middle of its longitudinal course; the intermediate ones, to the number of five, part at equal distances from one another in the oblique portion of the main stem, and are straight and parallel to the direction of the basal branch. The externomedian vein parts abruptly from the scapular vein shortly before the end of its basal course and runs subparallel to it, diverging gently from it in the apical half of the wing and emitting, at regular and distant intervals, three or four superior, gently arcuate, simple or forked longitudinal branches, commencing at a little before the middle of the wing, the first branch approaching the scapular vein and then continuing beside it; the area occupies only a narrow space at the extremity of the inner margin. The internomedian vein parts from the scapular just before the externomedian and in a nearly similar way; it runs nearly parallel to the latter, but with a very straight course, to about the middle of the apical half of the wing; normally it probably emits four or five simple or forked branches not quite so closely crowded as those of the two preceding areas; but in the specimen examined several of them spring from an offshoot of the second branch which runs parallel to the main stem, the latter forking once at its tip; there is also a strongly arcuate vein, close and parallel to the anal furrow, which seems to be a basal branch of this vein parting from it while still amalgamated with the preceding veins. The anal furrow is deeply impressed, strongly arcuate, roundly bent near the base, its apical half nearly straight, and strikes the inner margin a little before the end of the basal third of the wing; owing to the basal curve the anal area is nearly as broad as long, and is filled with six or seven nearly straight veins of varying obliquity, some of them branched and the branches uniting irregularly with the neighboring branches in a very peculiar manner, somewhat, apparently, as in *Bl. mantidioides*.

The fore wing only is preserved and is of a rather small size, being only 16.35 mm. long and 7.2 mm. broad, or the breadth to the length as 1 : 2.3; all the veins and their branches (excepting of course the anal furrow) are very delicate and the branches generally rather closely crowded; the surface appears to have been smooth as the interspaces are wholly unbroken by any cross nervules. The wing is nearly complete, but the margin is rather ragged and a considerable portion of the edge of the costal border appears to be gone.

From the comparatively small extent of the mediastinal area and the nearly parallel veins therein this species cannot be confounded with any other form of Mylacris.

The specimen occurred on dark grey shale, associated with ferns and leaves of *Sphenophyllum Schlotheimii*, and was found with the following species in the productive coal-measures (or middle coal-formation) of Sydney, Cape Breton, by Mr. Richard Brown, F. G. S., and communicated to me by Principal Dawson, to whose kindness I owe many similar favors.

Mylacris Heeri. Pl. 5, fig. 11.

Blattina Heeri Scudd., Can. Nat., VII, 272, fig. 2. Figured also in Dawson's Acadian Geology, Suppl. to 2d ed., p. 55, fig. 6.

Fore wing. The tip of the only specimen known is broken so that the exact form cannot be stated, but the wing was probably a little more than twice as long as broad; the costal margin is regularly and moderately convex, perhaps a little flattened in the middle; the base of the inner margin is nearly straight. The veins originate from a point a very little below the middle of the wing, and having scarcely the least upward curve at base are nearly straight. The mediastinal area is very large, regularly triangular, with only a few distant straight very gently diverging veins; in the specimen before me there are four veins, of which the lowest is forked almost at the base and the second in the middle; almost the entire costal edge preserved is covered by this area and it probably covered two thirds of the wing along this border, and occupied fully half the breadth of the wing at base. The scapular vein is very gently sinuous, being curved slightly downward close to the base and upward toward the tip, the intervening portion being straight and passing exactly down the middle line of the wing; the branches, four in number, are straight, equidistant, parallel to the nearer mediastinal veins, only the basal one (which originates very near the base) being forked and that close to the tip; the vein itself, judging from its apical direction, terminates just before the tip, leaving at the margin a very narrow field for this area. The externomedian vein is straight and forks probably at the middle of the wing; how many times it forks is uncertain, two branches only being present in the fragment; the area must occupy the whole of the apex of the wing. The internomedian vein is also remarkably straight, having only the slightest curve at the extreme base and probably terminating just as far before the tip as the scapular vein; it emits, in the fragment preserved, three rather closely approximated branches, the outer more longitudinal than the others and forked; from the course of the upper branch of this fork (not represented as sufficiently longitudinal in the plate) and from the absence of other primary branches from the apical portion of the main stem which is preserved, it is probable that this secondary branch runs parallel to the main stem and that the outer branches are emitted from it, as in the preceding species. In keeping with the straightness of the other veins, the anal furrow is exceptionally straight; it is deeply impressed only over its basal half and is very gently and equally curved throughout, terminating probably at about the middle of the posterior border; the anal veins are five or six in number, most of them forked near the middle, the innermost compound, and the outer more closely approximated than the others; all of them are straight beyond a frequently curved base.

The species is a tolerably large one, the fragment of the wing being 21 mm. long (its probable entire length about 25–26 mm.) and its breadth 11.8 mm., or the breadth to the length as 1 : 2.1. The veins and their branches are rather distinctly impressed, somewhat distant and regular; the interspaces are transversely and very faintly wrinkled, rather than provided with cross-nervules; the surface is nevertheless pretty smooth; the costal margin is very delicately marginate. The tip of the wing is broken off, so that from a fourth to a fifth is gone, but the fracture extends much further down the inner margin, extending even onto the anal area.

The course of the anal furrow separates this species from all others of the genus. In the structure of the internomedian vein, but in hardly any other special feature, it is allied to *Myl. bretonense*. In the general distribution of nearly all the veins it is very nearly related to *Myl. pennsylvanicum*, a slightly larger or at any rate a broader species; indeed these two species are more closely related than any other two American forms; but the slight curvature and consequently great length of the anal furrow of this species forbid their being considered the same, and this differs also from the other in the less crowded neuration of all parts of the wing, in the less sinuous course of the scapular vein, and in many other minor points.

The single specimen occurred on dark grey shale, associated with ferns and leaves of *Sphenophyllum Schlotheimii*, and was found, with the preceding species, in the productive coal measures (or middle coal formation) of Sydney, Cape Breton, by Mr. Richard Brown, F. G. S., and communicated to me by Principal Dawson.

Mylacris pennsylvanicum nov. sp. Pl. 5, figs. 13, 14.

Fore wing. Only the basal half of the wing is preserved, with none of the inner margin, so that it is impossible to determine the form of the wing; the course of the veins however would seem to indicate a shorter and stouter, as it certainly is a broader wing than in *Myl. Heeri*. The outline as given in fig. 14 probably makes the wing a little too long. The costal margin is regularly and considerably convex, more so than in *Myl. Heeri*. The veins originate from the middle of the wing or slightly below it, and curve a little at the base. The mediastinal area has a basal width of half the wing and, separated from the scapular by a scarcely curved line, strikes the costal margin close to the limit of the fragment, and probably somewhat, perhaps considerably, past the middle of the wing; the extreme base is covered in the specimen by a foreign object, but four veins appear beyond it,[1] the two middle ones simple, the others deeply forked, all tolerably close, scarcely divergent, oblique and very gently arcuate; toward the humeral angle there are no veins and the edge of the wing at this point is very narrowly and delicately marginate. The scapular vein is gently and broadly sinuous throughout and probably terminates before the apex of the wing, to judge from its apical curve; it runs very closely parallel to the costal margin through most of its course, and down very nearly the middle line of the wing, perhaps nearer the costal than the inner margin; it commences to divide very near the base and emits five branches, all but the first of which are simple and all are subparallel to the course of the outer mediastinal veins; the basal branch is doubly forked and renders this portion of the area a little more crowded. The externomedian vein is arcuate until it divides, before the middle of the wing certainly, and some distance before the extremity of the fragment; it forks only once however in the part preserved, two parallel veins running longitudinally to the edge, equidistant from each other and the veins on either side. The internomedian vein runs in a broadly sinuous course parallel to the preceding vein, and although much obscured upon the specimen, at least one and perhaps two branches can be seen to be emitted before the division of the externomedian vein. The anal furrow is strongly impressed upon its basal half, less so but still distinctly upon the apical half, appears to be composed of a pair of fine grooves closely approximated, and is regularly and not very strongly arcuate, terminating on the inner border at some distance before the

[1] In both the figures on our plate the vein nearest the humeral angle should be erased; it does not exist.

end of the mediastinal area, and about opposite the origin of the last scapular branch; the anal veins are numerous and crowded, the first deeply forked and basally distant from the furrow, the others simple and all slightly arcuate and subparallel to the basal half of the furrow.

The single known fragment represents a tolerably large species, the breadth of the wing being 13.5 mm., while its length may be estimated as anywhere from 24 to 30 mm., the actual length of the fragment being 19 mm. and the breadth to the length about as 1 : 2. It is the under surface of a left wing which is exposed, in which all the veins and branches of the costal half (namely those of the mediastinal and scapular areas) are prominent, while all the others are very obscure, and as the obscurity affects to some degree the anal furrow, it is probably entirely due to the preservation; by favorable light and on careful examination, slight indications of transverse wrinklings may be seen in the scapular area, but there could have been no regular nor definite reticulation.

The species, which is peculiar for its breadth and the slight tendency of its branches to subdivide, appears at first glance to have considerable resemblance to *Myl. Heeri*; but it is certainly distinct from that by the stronger curvature of the anal furrow and consequent abbreviation of the anal area; it also differs by the sinuosity of the scapular vein, the more arcuate line of separation between the mediastinal and scapular areas and the more crowded branches of at least these areas. From *Myl. anthracophilum* it may be distinguished by the lack of the strong deflection of the base of the principal veins, by its less crowded venation, simpler branches and by the direction of the branching portion of the scapular vein, which is parallel to the border in this species, but converges toward it in *Myl. anthracophilum*.

A single specimen, marked No. 284 by the discoverer, Mr. I. F. Mansfield, was found at Cannelton, Beaver Co., Penn., in dark sandy shale immediately under a vein of cannel coal known as the vein C of Professor Lesley. It is partly covered by a leaflet of *Sphenophyllum Schlotheimii*. Lower coal measures of Penn.

Mylacris anthracophilum. Pl. 5, figs. 6-8.

Mylacris anthracophila Scudd., in Worth. Geol. Surv. Ill., III, 568–70, figs. 5, 6.

Fore wing. The wing is very broad at the base and tapers almost from the base by the slope of the costal margin, which is strongly and regularly arcuate, while the inner margin is nearly straight, bringing the rounded but rather produced apex in the lower longitudinal half of the wing; the extreme apex is broken. The veins originate below the middle of the base and curve strongly upward before assuming a more longitudinal direction, when all are subparallel to the costal margin. The limitation between the mediastinal and scapular areas is strongly arcuate basally, straight apically, and the mediastinal vein terminates at the end of the apical three-fifths of the wing; the mediastinal branches, three or four in number, most of them forked, are straight or very gently arcuate, and radiate from a common point near the middle of the base of the wing, some of them plainly emitted from the principal vein just beyond the base, and one from the same at a considerable distance from the base. The scapular vein is strongly arcuate at the base, but, next the last branching of the mediastinal vein, takes a nearly straight longitudinal direction, subparallel to but slightly converging toward the costal margin, and terminates near or at

the tip of the wing but below the middle line of the same; it emits five equidistant almost equal longitudinal branches, each of which forks at or somewhat beyond its middle and at similar distances from the costal margin; the mediastinal and scapular branches accordingly change their direction in the most gradual way from nearly transverse to longitudinal, and the mediastinal and scapular areas together occupy nearly one-half the width of the wing. The externomedian vein, strongly arcuate, like the preceding, at the base, begins to divide as soon as that, and beyond this is straight, terminating at a short distance before the tip of the wing; its first branch passes down the middle of the wing and dies out a little beyond the middle; its three other branches, which like the first are superior, are emitted further out in the apical half of the wing and are each simply forked before their middle; the upper fork of the first of these approximates very closely to the scapular vein, leaving no passage for the basal branch. Beyond the base the internomedian vein is also straight and emits four equidistant branches, the first (at near the origin of the basal branches of the preceding veins) being doubly, the others, excepting the apical, simply forked. The anal furrow is deeply impressed, very regularly and rather gently arcuate, terminating a little before the middle of the wing; the anal veins are numerous, gently sinuous and mostly simple, the upper ones deeply forked and more distant.

The species is a little above the medium size, the length of the fragment preserved 28.5 mm., being scarcely shorter than the real length of the wing; its greatest breadth, at the end of the basal fifth, 13.5 mm, or the breadth to the length as 1 : 2.1. The specimen is very nearly perfect, and represents the upper surface of a right wing; the anal area is swollen; the veins of the wing are prominent, and the interspaces are rather regularly divided by inconspicuous straight cross-lines.

The species is remarkable in this genus for the form of the wing, which has its tip noticeably within the middle line of the wing and somewhat produced. In this it differs decidedly both from *Myl. bretonense* and *Myl. Mansfieldi*. It agrees better in this point with *Myl. Heeri*, but the crowded neuration of *Myl. anthracophilum* with the strong deflection of the base of the veins distinguish it at once from that species. There is only left *Myl. pennsylvanicum* with which to compare it; and although the apex of that species is so far lost as to render it very imperfect, we may be sure from the sinuosity and apical curve of the scapular vein that the apex of the wing is not within the middle line; it is further distinguished from *Myl. pennsylvanicum* by its tapering form and the very strong basal deflection of the veins; so that this species is abundantly distinct from all the others. Besides the front wing a pronotal shield has been found. At least it probably belongs to this species, as the size agrees and both came from the same locality and were collected at the same time. It is of nearly the same form as in *Periplaneta americana* (Linn.), broadest in the middle of the posterior half where it is roundly angulate, and in advance of which it tapers very rapidly to a convex front, hardly angulate laterally; posterior border broadly and strongly convex; its immediate edge narrowly and very slightly raised; the whole pronotum is a little convex, and the surface is nearly smooth, with a few minute transverse and longitudinal lines; its greatest breadth is 16 mm.; its anterior breadth 9.5 mm.; length 12 mm.

The specimens above described were found by Mr. A. H. Worthen, at Colchester.

McDonough Co., Illinois, in the roof shales of coal No. 2 of the Illinois Survey, and by him communicated to me. Lower coal measures of Illinois.

Mylacris Mansfieldii nov. sp. Pl. 5, fig. 15.

Fore wing. The base of the wing is broken, but the part preserved shows an oval outline, with similarly arcuate costal and inner margins and a somewhat pointed tip, the extremity of which is rounded; the tapering of the wing includes all the apical half. The mediastinal area is very large, occupying fully one-half the breadth of the wing at the base and covering about two-thirds of the costal margin; the veins of its outer half (the base is broken in the specimen) are very long, very slightly arcuate, slightly radiate but subparallel, simple or deeply forked and closely crowded, and the limitation of the area next the scapular vein is straight. The scapular vein runs nearly parallel to the costal margin, at least in the middle of its course, but in the apical third becomes longitudinal, passing down the wing scarcely above its middle line; it commences to divide near the base of the fragment, and probably a little before the end of the basal third of the wing, and emits five branches at unequal distances apart, one or two of which are singly or doubly forked, and all run parallel to the outer mediastinal branches; the vein terminates at the tip of the wing and so the area occupies on the margin the apical third of the costal border. The externomedian vein has a slightly arcuate course, which, contrary to what is customary, runs subparallel to the inner margin and, commencing to divide a little before the middle of the wing, emits, near together, three inferior branches which are long, simple or forked and longitudinal, the basal ones more or less arcuate in the same sense as the main vein; as these branches are inferior, the interspace between the scapular and externomedian veins (running almost exactly down the middle of the wing) is marked by the divergence of the opposing nervules. The internomedian vein is broadly arcuate and terminates on the inner border considerably nearer the tip than the mediastinal vein; it emits three branches, the apical one compound, the others more or less deeply forked, so that this area is as crowded with veins as the others. The anal furrow is lightly impressed, scarcely arcuate in its apical half, and terminates at the edge of the fragment, probably at about the end of the basal half of the wing.

The species is a tolerably large one, the largest of the genus, the fragment of the wing measuring 24 mm. in length and 13 mm. in breadth; probably the entire length was about 30 mm. and the breadth to the length as 1 : 2.3. The wing is a left one and the upper surface is exposed; the veins are lightly impressed throughout and uniformly and rather closely crowded; the surface is nearly smooth, but with care a delicate wrinkling of obscure transverse lines can be made out.

The wing is peculiar for its tapering oval form and the inferior origin of the externomedian branches, which distinguishes it at once from every other species of this genus.

The single specimen found was sent to me by Mr. I. F. Mansfield and by him obtained at Cannelton, Beaver Co., Penn., in dark sandy shale immediately under the vein of cannel coal known as vein C of Professor Lesley. Lower coal measures of Pennsylvania.

Lithomylacris nov. gen. (*λίθος, μυλακρίς*).

The mediastinal vein of the upper wings consists of about five principal shoots, only two or three of which fork and these generally close to the base, all of them straight or gently curved, and the outermost extending to variable distances along the costal margin, but generally beyond the middle of the wing; the point toward which these branches converge is considerably nearer the inner than the costal margin of the wings; this with the great length of the outermost shoot gives the mediastinal area an unusual extent for Mylacridae. The scapular vein is considerably curved before branching, but beyond its first branch is almost exactly straight, even the outer portion scarcely curving, and runs down the middle line of the wing to the tip, so that the mediastinal and scapular areas together occupy fully half of the wing; it emits four or five branches, more or less closely approximated, according as one or two of them fork or not, and all run subparallel to, but rather less obliquely than, the outer branches of the mediastinal vein. The externomedian area is very narrow and of small extent, occupying the lower half of the narrow tip of the wing, the vein first branching at or beyond the tip of the wing, and then but once or twice, either superiorly or inferiorly, the first branch sometimes forking. The internomedian and anal veins together divide nearly equally between them the inner margin of the wing, the anal furrow being rather conspicuous and gently arched, and, from the narrowness of the wing and the inferior position of the common point of origin for all the principal veins, unusually longitudinal, most of the species differing in this respect somewhat conspicuously from those of Mylacris; the internomedian vein has only two or three branches, which are very longitudinal and very long, and yet fork comparatively little, rarely doubly; the vein may emit its first branch somewhat before, opposite to, or considerably beyond the origin of the first branch of the scapular vein. The branches of the anal vein are known only in one species, where they are parallel, rarely fork, and are slightly more longitudinal than the branches of the internomedian vein.

The wings are remarkable for their elongate form and nearly parallel sides; the greatest breadth is at about the middle and they are generally three times as long as broad, being exceptionally slender for Mylacridae.

Upper wings are all the remains known of this genus, which differs from Mylacris in the more attenuated and equal shape, the slight obliquity and gentle curve of the anal furrow, the slight importance of the externomedian area, and also by the unusual sulcation of the interspaces between all the veins; from Necymylacris it is readily separated by the very wide extent of the combined mediastinal and scapular areas. The species are all of rather small size and are found only in America.

Lithomylacris angustum nov. sp. Pl. 5, figs. 2, 3.

The fore wing is long and very slender, the inner margin straight, the costal margin very gently and regularly convex; the wing narrows from the middle, at first very slightly, in the apical fifth more rapidly; the tip is broken in part, but was evidently well rounded and, from a less rapid narrowing of the wing, probably not so slender as in the preceding species. The veins take their rise from a point considerably below the middle of the wing, the lower ones scarcely curving upward in passing outward, the upper ones curving very gently and broadly next the base. The mediastinal area is fully half the width of the

wing at the base, and occupies very nearly two-thirds of the costal margin, its limitation next the scapular area being almost straight, a slight sinuosity being scarcely perceptible; the gently radiating veins of this area are six or seven in number, those next the shoulder simple and distant, the two outer somewhat sinuous, simply or doubly forked and closer. The scapular vein curves gently upward at the base until it has nearly reached the middle of the wing, next passes down the middle or slightly below it, subparallel to the costal margin, and then curves gently upward again, its entire course being very broadly and gently sinuous, terminating at the apex; it begins to divide at the end of the basal fifth of the wing, almost before it has lost its upward curve, and emits half a dozen oblique branches, the first pair near together, the rest at subequidistant intervals; the second and third are forked near the middle (one of the branches of the former again at the tip), but the others are simple; they become increasingly longitudinal toward the tip but only to a very slight degree, continuing the decreasing radiation of the mediastinal veins; together these two areas occupy more than half of the wing. The externomedian vein runs in a straight course nearly to the middle of the wing, scarcely turned downward from a longitudinal direction; here it forks, the upper branch again forking near the tip, the lower at less than half way to the border, each of the latter forks again dividing, the upper before, the lower beyond its middle; all follow a longitudinal direction and occupy upon the margin only the lower half of the narrow apex of the wing. The internomedian vein is remarkably straight throughout and is indeed the only palæozoic cockroach known in which it is straight; it terminates just before the tip of the wing, commences to divide almost as soon as the scapular vein, and emits, long before the middle of the wing and at regular and short intervals, three straight veins, the first simple, the others forked in the middle, all having a constantly lessening obliquity, so that the outermost fork is parallel to the main vein; besides these the main vein emits another slight longitudinal branch close to the apex, and the whole area occupies about one-half of the inner border of the wing. The anal furrow is very deeply and sharply impressed and scarcely at all arcuate, running in nearly a straight line to a little before the middle of the wing; the anal veins, four in number, one of the middle ones forked, are straight, equidistant and parallel to the furrow.

The wing is a little above the medium size, 29.5 mm. long, and yet only 9.5 mm. broad, or the breadth to the length as 1 to a little more than 3. It is nearly perfect, being only a little fragmentary about the base and the lower portion of the tip. It is a left wing, of which the under surface is exposed, showing the veins and anal furrow as ridges; the anal furrow is remarkably prominent, and most of the veins are also very prominent; this is especially true in the veins of the scapular and externomedian areas; the internomedian vein itself, as far as its apical fork, is also almost equally prominent, but all its branches are mere lines upon a flat field; while in the areas covered by the prominent veins the interspaces are roundly sulcate, giving additional prominence to the veins; in the mediastinal area, however, where the veins are somewhat prominent, the interspaces are not sulcate, and the anal area, which must as a whole be broadly vaulted or tumid as seen from the upper surface, partakes of the nature of the internomedian area; the surface itself of the whole wing is smooth, no trace of cross venation being discernible. From its deflection in the reversed specimen, it would seem that the whole costal edge was slightly margined.

This species, like the next, is peculiar for the division of the internomedian vein, which, excepting for a small apical fork, emits all its branches near the base; in shape it closely resembles that species, even to the flatness of the internomedian area; but it differs from it in its greater length, the greater frequency of the branches, and their much more abundant forking, especially in the externomedian vein, which also divides much nearer the base in this species than in *Lith. pittstonianum*. The shape of the wing and the closer venation at once separates this species from *Lith. sulcatum*.

The single specimen was found with the following species by Mr. R. D. Lacoe, at Port Griffith switch-back, near Pittston, Penn., in the roof shales of the E seam of coal of the Second Pennsylvania Survey, and by him forwarded to me for examination. Upper coal measures of Pennsylvania.

Lithomylacris pittstonianum nov. sp. Pl. 5, figs. 4, 10.

Fore wing. The single specimen known is very imperfect, the base, anal area, and a large part of the tip being lost, and the remainder badly fractured; it is evident, however, that the wing is very long and slender, with a gently and regularly arcuate costal margin; probably the wing is nearly equal, tapering very gently on the apical half. The veins must originate below the middle of the wing, and are nearly straight. The mediastinal area, which is more than half the width of the wing at the base, terminates at the middle of the costal margin, and is separated from the scapular area by a straight border, the veins, six or seven in number, being straight, gently divergent, and simple or rarely connected close to the base. The scapular vein runs parallel to the costal margin in the basal half of the wing, gradually approaches it in the apical half, and terminates probably a little before the tip; it emits five simple, straight branches, which divaricate very slightly in continuation of the divergence of the mediastinal veins, which they entirely resemble; the mediastinal and scapular areas together occupy just about one half of the wing. The externomedian runs parallel to the scapular vein, divides a little beyond the middle of the wing, and emits about four inferior, slightly arcuate branches, which are simple (unless the first be apically forked), and together probably occupy the entire apical margin of the wing. The internomedian vein is very gently arcuate, and must terminate just before the tip of the wing; it emits, wholly in the basal third of the wing, three simple or simply forked branches which are very longitudinal. The anal furrow is distinctly but not heavily impressed, very gently arcuate, and must terminate at about the end of the basal third of the wing; but such is the slenderness of the wing and the low origin of the principal veins, that the anal area must be several times longer than broad.

The wing is of moderate size, the fragment measuring 22.5 mm. in length and 8.5 mm. in breadth; probably the entire length of the wing is 26 mm., or the breadth to the length as 1 : 3; it is a left wing with the upper surface exposed; the veins are all very distinctly impressed, excepting those of the internomedian area, which are obscure; the interspaces between the veins are vaulted also, so as to add to the impression of the veins themselves; but otherwise it is smooth excepting in the flatter internomedian area, where a delicate and crowded cross-veining is faintly marked; the basal third of the costal edge is gently margined.

With the preceding species, this insect is peculiar for the basal attachment of the internomedian branches. In its shape it resembles only *Lith. sulcatum* in this genus; from

this it differs in the simplicity of the branches, which are very rarely furcate; consequently the venation is much more open, and in this respect it approaches *Lith. simplex*, with which, from its shape, it could not possibly be confounded.

The single specimen found was obtained by Mr. R. D. Lacoe with the preceding at Port Griffith switch-back, near Pittston, Penn., in the roof shales of the E seam of coal (of Prof. Lesley's table). Upper coal measures of Pennsylvania.

Lithomylacris simplex nov. sp. Pl. 5, fig. 5.

Fore wing. The wing is long oval, tapering beyond the basal third, but very gradually, the costal margin much arched next the base, the humeral lobe being large and well rounded; but along the most of its course the costal margin is very gently convex, almost straight in the middle; inner margin gently convex, the tip tapering but well rounded; the wing is much broader than in the other species of the genus. The veins originate somewhat below the middle of the wing, and curve upward very slowly with a broad arcuation. Mediastinal area occupying more than half the base of the wing, and on the costal margin almost the entire extent of the wing, terminating only a little before the tip; it is separated from the scapular area by a very gently and broadly arcuate limitation, and is filled with very few veins (only three in the specimen seen), each of which forks once near or at its base; all are divergent and gently and broadly arcuate, the outer the least so, and all fail to reach the margin. The scapular vein is very broadly arcuate, running down the middle of the wing parallel to the costal margin, and, finally longitudinal, terminates just beyond (*i.e.*, below) the extreme tip of the wing; it commences to divide while still arcuate, just beyond the basal fourth of the wing, and emits at subequal distances apart four simple, gently arcuate branches, having a similar direction to the outer mediastinal veins, but if anything less longitudinal. The externomedian vein, arcuate as far as the division of the scapular, is straight beyond this, parallel to and rather distant from the same, forking simply at the end of the middle third of the wing, and occupying only an inconsiderable space on the border just below the tip of the wing. The internomedian vein is similar to the preceding at the base, but becomes straight a little sooner and continues straight to the tip, terminating about as far from the apex as the mediastinal vein; it emits a very short branch close to the tip, another a little beyond the middle of the wing, and two others, which must have their origin much nearer the base, as in the other members of the genus; only the apical portion of the outer of them, however, can be traced on the specimen. The anal furrow is distinct but not deeply impressed, is very regularly and rather gently arcuate, and terminates just beyond the middle of the wing, affording a very large anal area.

The wing is of medium size, measuring probably 24 mm. in length (the fragment is 22.5 mm. long) and 10 mm. in breadth at the middle, which is probably not quite so broad as the middle of the basal half of the wing; or the breadth is to the length as 1 : 2.4. It is nearly perfect, a small portion of the tip only being lost, together with the whole anal area; it represents a left wing seen from the under surface, the veins being in relief; the veins are prominent, but not remarkably so, and the anal furrow no more prominent than they, if it is as prominent; as in the preceding species, the branches of the internomedian vein are not elevated; indeed they cannot all be traced in the somewhat worn specimen, and the vein itself, as well as the externomedian, partakes in part of the obscurity; this

region also is flat, while the interspaces of the scapular and mediastinal areas, especially of the former, are broadly sulcate (*i. e.*, arched on upper surface) but much less so than in the other species of the genus; the surface seems to be completely smooth, is of a carbonaceous black in the specimen, distinguishing it strikingly from the clay-colored matrix. The extreme edge of the entire humeral lobe is marginate as far as the mediastinal veins.

The wing is peculiar for the very large proportion which the mediastinal and anal areas occupy to the rest of the wing, and for the extreme simplicity of the neuration, in which there is not a single forked branch outside the mediastinal area; the veins are very distant and the species is at once distinguished from the others of the genus by the much stouter shape of the wing, which is much less, while they are much more than three times as long as broad.

The single specimen discovered was obtained by Mr. Wm. Gurley, from the coal measures of Illinois, about six miles from Danville, and sent me by him for study. Lower coal measures of Illinois.

Necymylacris nov. gen. (*νέκυς, μυλακρίς.*)

The mediastinal vein of the upper wing differs from the same vein in the other members of this group, to judge at least from the most perfect specimen, in emitting from the outermost vein several branches at infrequent intervals, even to a long distance from the base; these branches may themselves be compound, so that a certain resemblance or approximation to Blattinariae may be seen; but, in addition to these, there are the usual radiating veins next the humeral lobe; in the typical species, the only perfect specimen of the genus known, the last vein terminates in the middle of the apical half of the wing, but in the other it appears to be much shorter. The scapular vein, curved or bent before branching (which it does near the end of the basal third of the wing) thereafter runs in a straight or sinuous course to a little before the tip of the wing, emitting three or four veins which may be multiple-branched or perfectly simple. The externomedian vein is forked a little before the middle of the wing, and emits a number of forking branches, which, while they are longitudinal in direction, are superior, so that the equal interspace between the externomedian and internomedian veins is marked by oppositely diverging branches; the externomedian area occupies the entire or almost the entire apical border of the wing, so that it is of a narrow wedge-shaped form. The internomedian area is apparently more extensive than the anal, the anal furrow terminating on the inner margin nearly opposite the termination of the mediastinal area and having a rather oblique curving course; the internomedian vein emits five to ten branches, generally simple, occasionally forked at the base, and in one of the species itself forks longitudinally not far beyond the middle, the upper fork dividing near the tip and the lower emitting the apical branches; these all run in a slightly curved course more oblique than the anal furrow. The branches of the anal vein are numerous, run more longitudinally, are more closely crowded toward the anal angle and fork feebly, excepting the upper one which, though considerably curved, is well separated from the anal furrow and emits several inferior branches.

Besides upper wings, the slight fragment of a part of one of the lower wings has in one instance been found, in which the veins of the apical portion are thickly crowded, straight and parallel, and fork feebly toward their tip.

The genus differs from the two preceding by the smaller extent, both in breadth and length, of the combined mediastinal and scapular areas; from both also, but particularly from Lithomylacris, in the great extent of the externomedian area. The species are of large size, including the largest American forms, and are unknown to Europe.

Necymylacris lacoanum nov. sp. Pl. 5, fig. 12.

Fore wing. The form is indeterminable from the only fragment known, although it is probably proportionally shorter than in *Nec. heros*; the veins are all strongly curved at the base. The mediastinal area is less extensive than in the other species of the genus, and resembles the other genera of Mylacridae to a greater extent in a more radiate disposition of the veins, at least four in number, of which the last has at least three rather distant and apparently simple branches, the outermost originating at some distance beyond the first division of the scapular and internomedian veins; probably the area does not extend beyond the middle of the wing. The scapular vein has a rather strongly sinuous curve and at least three straight and simple branches, of which the first, probably arising in the middle of the basal half of the wing, is in direct continuation of the basal portion of the vein, and thus separates the scapular from the mediastinal area by a straight line; the branches are parallel to the outer of the mediastinal veins, and the area, which is certainly broad, probably more than a third of the breadth of the wing, extends no doubt nearly to the tip of the wing. The externomedian vein beyond its basal curve is straight, and first divides beyond the last (preserved) branch of the scapular vein, or, probably, shortly before the middle of the wing; it emits at least two superior branches, the simple bases only of which are preserved in the specimen, but, from the divergence of these, the area probably occupies the entire apex of the wing. The internomedian vein is regularly and very strongly arcuate, probably terminating at some distance before the tip, and emits four equidistant, well-separated branches, one of which is deeply forked, the others simple, all straight or gently arcuate and very long, the area occupying apparently more than half of the wing. The anal furrow is scarcely more distinct than one of the veins, and is nearly as straight as they, appearing to originate from the internomedian vein near the base of the wing, and terminating probably a little before the middle of the wing; the anal veins are numerous, especially toward the basal angle, gently arcuate, simple or forked, the outer one very much curved, distant from the others, and compound.

The wing is of medium size, the largest fragment measuring about 13 mm. long, and the breadth of the two fragments when united nearly 12 mm.; probably the entire length of the wing was about 25 mm., and the breadth to the length as 1 : 2. It is a left wing, of which the upper surface is exposed, but is very fragmentary and shattered, no part of the border, unless in the unimportant anal area, being preserved; probably nearly half of the apex is gone, as well as a slight part of the base; the veins are delicately impressed, but distinct, excepting toward the costal border, and the surface flat, and, at least in the internomedian and anal areas, rather distinctly marked with very frequent transverse wrinkles.

Hind wing. Protruding from beneath the front wing is a small fragment of a hind wing, apparently the apical lower portion of that of the opposite side of the body; all that can be made out are about a dozen straight equidistant parallel veins, about half of them (mostly those nearer the apex of the wing) forking simply; their direction, as they lie on

the stone, is parallel to that of the scapular veins of the front wing. In distinction from the veins of the front wing, these are slightly elevated, and the basal half of the fragment has a glistening surface, while that of the apical half is dead and shows exceedingly faint traces of transverse wrinkling like the cross neuration of the front wing. If, as the direction of the veins leads us to suppose, the wing is that of the opposite side of the body, and has its natural position as closed, the hind wing of this insect must have been very broad, broader indeed than the remains of any other palaeozoic cockroaches would lead us to presume in them.

Notwithstanding the fragmentary nature of the fossil, it is plainly distinct from any other known form. The structure of the mediastinal vein, although approximating to a certain degree that of the Blattinariae, plainly shows it to belong to the Mylacridae, and is indeed not very different from the same vein in *Lithom. angustum*, while the very arcuate form of the internomedian vein, combined with the great breadth of this area, separate it at once from all the species of Mylacridae mentioned here. Its generic affinities with Necymylacris are doubtful, and the material is insufficient for accurate determination of all the points which should be settled before reference to a distinct genus can be made, but it agrees with that genus to a certain extent in several points in which it differs from other Mylacridae, and especially in the mediastinal vein (although it is here very much simpler than in *Necym. heros* — as indeed is the whole neuration) and in the anal area, whose extent and the distribution of whose branches, and particularly the character of the compound branch next the anal furrow, is very similar.

The single specimen known (numbered 2009) was found by Mr. R. D. Lacoe in the lowest productive coal measures near Pittston, Penn., and by him sent me for examination.

Necymylacris heros nov. sp. Pl. 5, fig. 9.

Fore wing. The wing is long and slender, very long obovate, nearly equal; the costal margin is very gently convex, nearly straight along the middle, the inner margin even less convex, and the gently tapering apex rounded; the veins originate from near the middle of the base of the wing, and most of them curve upward a little for a short distance. The mediastinal vein is at first directed toward the middle of the basal half of the costal margin, but close to the base bends abruptly, and runs in nearly a direct line to the middle of the outer half of the costal margin, separated therefore by a straight line from the scapular area; next the humeral lobe, which is smooth, are two or three weak radiating veins which spring from the base of the principal vein; but most of the slowly narrowing mediastinal area is filled with scarcely radiating branches which spring unequivocally from the main vein beyond the base; there are three such principal branches, all originating in the basal third of the wing and compound, besides a simple apical branch near the tip; each of these compound branches, which are as nearly longitudinal as their position allows, emits, generally at some distance from its base, two or three outer simple or forked branches, so that the costal margin is filled with crowded veins. The scapular vein, gently arcuate until it divides, near the middle of the basal half of the wing, is thereafter straight, running down near the middle line of the wing and parallel to the costal margin a little beyond the middle of the wing, however, it is deflected very slightly upward, the change being scarcely perceptible, and terminates on the apical margin just before the

extreme apex; it emits four branches at unequal distances apart, all of them nearly longitudinal, the first being compound and dividing only at the middle of the wing,[1] the second doubly forked, and the third simply forked, both at a long distance from the origin, while the last, arising opposite the fork of the third, is simple. The externomedian vein is very broadly sinuous, being rather strongly arcuate at the base, then runs in a nearly straight line a little divergent from the costal margin, and, finally, in the apical third of the wing, becomes more longitudinal, and terminates just before the apical margin; it first divides opposite the second branch of the scapular vein, or at the end of the basal two-fifths of the wing, and emits at subequal intervals, the last a little beyond the middle third of the wing, four superior longitudinal branches, the first of which runs down the middle line of the wing, forks at a little before the end of the middle third of the wing, its upper fork again dividing; the second forks in the middle of its course, and the others are simple; all are closely crowded together, and occupy upon the border the lower part of the apical margin. The internomedian vein follows nearly the direction of the preceding, being strongly arcuate at the base, straight and considerably oblique in the second quarter of the wing, beyond this subparallel to the costal margin; at its change of direction, almost exactly in the middle of the wing, it emits a branch, which runs close to the main stem, and, excepting for an apical shoot, emits all the regular branches beyond its origin; including these secondary branches there are about ten simple slightly arcuate oblique veins, whose direction, especially that of the basal ones, is rather at variance, from their regular obliquity, with that of the branches of all the other veins; the basal branches are more closely approximated than the apical. The anal area being broadly tumid, the anal furrow is very deeply impressed, and is very strongly arcuate on the basal half, nearly straight on the apical half, and terminates a little before the middle of the wing; the anal vein next the furrow is straight and nearly longitudinal at base, curved gently downward beyond, and emits three or four arcuate distant branches; the other veins are very numerous and crowded, generally simple, nearly straight or arcuate, in an opposite sense to the first, and about as longitudinal as the mediastinal branches.

The wing is of extreme size, the largest of the American species, and only exceeded by *Anthracobl. spectabilis* of Europe; it is 48 mm. long and 18 mm. broad, or the breadth is to the length as 1 : 2.7; the specimen is almost absolutely perfect, and represents the under surface of a right wing; the principal veins and the main branches of the mediastinal, scapular, and externomedian areas before they fork are all distinctly pronounced; the forks of the same are delicately elevated, while the branches of the internomedian and anal areas are very delicately impressed,—all as seen on the under surface; the surface is flat, excepting where the principal veins are most pronounced, and here the interspaces are a little and broadly sulcate; all the interspaces, even in the anal area, but especially those which are sulcate, exhibit a minute tracery of nearly straight, very closely approximated, excessively delicate, scarcely impressed cross lines; those of the anal area are not sufficiently distinct in the plate.

This insect, from its extreme size alone, cannot possibly be confounded with any other American species, nor from the peculiar distribution of the mediastinal branches, in longitudinal bunches depending from the main vein, with any palæozoic species. This peculi-

[1] The plate represents the first offshoot of this first branch as simple, but this is inaccurate, and was overlooked in revision; it forks near the tip or directly opposite the extremity of the first branch itself.

arity of the mediastinal vein is of special interest as showing a certain affinity to the Blattinariae, next which it is here placed; yet the distribution of the branches is nevertheless radiate, and the form of the area triangular and not band-shaped, according in this respect wholly with the Mylacridae. It should be taken as the type of Necymylacris, for the imperfection of the preceding species renders its alliance with this somewhat doubtful.

The single specimen, which I owe to the kindness of Mr. I. F. Mansfield, was obtained by him at Cannelton, Beaver Co., Penn., in a dark sandy shale immediately under the vein of cannel coal known as vein C of Professor Lesley. Lower coal measures of Pennsylvania.

Blattinariae.

In the second group into which the palaeozoic cockroaches may be divided, the mediastinal vein is not constructed like the anal vein, but like the other veins of the wing, being composed of a main vein which extends at least half way to, usually some way beyond, and sometimes quite to, the tip of the wing, emitting toward the costal border several branches which are usually subequal, equidistant and parallel, often forking once in some part of their course, the apical branches occasionally many-branched. The area covered by this vein and its branches is thus band-shaped, and terminates beyond the middle of the wing. The group occurs both in Europe and America, all of the European and somewhat less than half of the American species falling therein. The wings as a general rule are slenderer than those of most of the Mylacridae, the breadth being contained in the length on an average more than two and a half times.

Etoblattina (ἔτος, Blattina) nov. gen.

Blattina Auct (pars).

The mediastinal vein of the fore wings with its branches covers a rather narrow and not very extended area, being seldom more, seldom much less than one-fourth of the width of the wing, and generally terminating apically from a little more than one-half to a little less than two-thirds the distance toward the tip of the wing; in one or two instances, as particularly in *E. leptophlebica*, it extends a little more than two-thirds the distance; the area is usually of uniform width nearly to the tip, but it sometimes tapers throughout the entire apical half, and in *E. primaeva*, where the whole wing is very broad, it tapers with unusual rapidity and throughout the greater part of the wing; the principal vein emits from five to ten simple or forked, equidistant, oblique branches. The scapular vein generally terminates just before the tip of the wing, rarely at the tip itself, and occasionally is decidedly removed from the tip, though not to a great distance; it generally begins to fork a little before the middle of the wing, occasionally at it, and rather more frequently only one-third the distance from the base; and the branches usually take on the mode of distribution of those of the mediastinal vein, although the similarity is sometimes lost from the greater breadth of the area and the consequently greater length of the veins; in other instances, and particularly in those in which the early branching of this vein is correlated with more than an average length in the mediastinal area (as particularly in *E. venusta*), all similarity is lost, the division assuming more or less of an arborescent form, generally accompanied by frequent ramifications; as a general rule, however, more or less similarity exists between the two areas, and in some (as in *E. affinis*, *E. Dohrnii*) the resemblance is

very great; the general course of the scapular vein is usually parallel to the costal margin, but without partaking of its generally slight convexity; beyond the immediate base of the wing therefore its course is nearly straight, sometimes with a gentle sinuosity; occasionally it is conspicuously sinuous, as in *E. labachensis*, so that the greatest breadth of the scapular area is double that of the mediastinal; yet even here the general resemblance and trend of the branches of the two veins may be perfectly kept. The externomedian vein is of moderate importance, occupying always a portion, generally the whole, of the apex of the wing, generally commencing to branch not far from the first divarication of the scapular vein, but in this respect showing great variation; its branches are not numerous, occasionally reduced to two or three, and while longitudinal are yet always superior, so that the equal sinuously curving space between the externomedian and internomedian veins is always marked by divergent branches, very frequently arising exactly one opposite another. The internomedian vein originates near the middle of the wing in about half of the species (the first half of the species described below), somewhat above the middle in the other half; usually it is pretty straight beyond the arched base, and does not terminate so near the apex of the wing as does the scapular vein; but not infrequently it reaches as far as the scapular, or at any rate extends further than it otherwise would by curving outward near the tip, and thus reaching to a greater distance; there is therefore much difference in the rapidity with which this area narrows, being very rapid in some (as in *E. russoma*), very gradual in others (as in *E. Lesquereuxii*); its numerous veins are nearly straight; usually some of them are simple, and they have an obliquity about equal to those of the mediastinal vein, although of course in an opposite sense. The anal furrow is rather more lightly impressed than usual, arcuate and very oblique, generally terminating on the inner margin at about two-fifths the distance from the base; the veins of the anal area are usually simple or forked near the base, very frequent, subparallel and subequidistant, generally less arcuate than the anal furrow; in one species, *M. mantidioides*, they are very irregular.

Usually the upper wings are moderately slender, from a little less than two and a half to about two and three-quarter times as long as broad; but a few of the species have wings more than three times as long as broad, and the first two species differ from the others, not only in their unusual breadth, being only a little more than twice as long as broad, but also in other features, such as an unusual breadth (and in *E. labachensis* an unusual length) of the mediastinal area, the narrowness of the externomedian area, and the extreme longitudinality of its branches; as, however, the form of the wing often appears to differ very considerably in species of the same genus in this group, there is not sufficient ground for the separation of these species from the others even as a section, and the more so as there are several other species, placed in the middle and at the other extremity of the genus, which have quite as broad wings. The general average is scarcely less than two and three-quarter times longer than broad, which is a trifle slenderer than the average of the whole tribe; and it is not a little curious that this is exactly the same proportion as holds in the genus next to this most prolific in species, Gerablattina.

Besides the front wings, which constitute most of the fragments of this genus preserved, there are two which show the hind wings also; one of these also has the thorax and abdomen, and a third the thorax. The hind wings appear to resemble the front wings closely, and not to be much larger, at least in one of the species; the thorax in both

is similar, being subtriangular, tapering anteriorly, but with rounded sides and a rounded front. The abdomen in the single species where it occurs is extraordinarily slender, but apparently not cylindrical, as would at first appear from Goldenberg's illustration.

This genus differs from Archimylacris in the greater conformity of the mediastinal and scapular areas, the superior position of the branches of the externomedian vein, and the usually smaller extent of the scapular area; from Anthracoblattina, Gerablattina, and Hermatoblattina by the greater brevity of the mediastinal area and the correlated greater importance of the scapular area, as well as from the former by the superior position of the veins of the externomedian vein, and from the latter by the superior position of the branches of the scapular vein; from Progonoblattina it is readily separable by the unimportance of the externomedian area; Oryctoblattina differs from it in its excessive and peculiar development of the mediastinal area with its inferior branches, and by the excessive narrowness and length of the mediastinal area, as well indeed as by nearly every other feature in the wing; while Petrablattina, with the extraordinary development of its externomedian area, formed of longitudinally directed but yet superior branches, can be confounded with no other.

This genus is by far the most numerous in species of all the carboniferous types, a third of the species belonging to it; it is, however, almost exclusively European, for only two American species fall into it, one of these the first described from America; this is not a little curious, for the first known fossil cockroaches of the European coal measures also fall into this genus.

Etoblattina primaeva. Pl. 3, fig. 7.

Blattina primaeva Gold., Sitzungsb. math-nat. Cl. k. akad. Wiss. Wien, IX, 38; — Ib., Palaeontogr., IV, 22, taf. 3, fig. 4; — Ib., Foss. Ins. Saarbr., 6, taf. 1, fig. 4; — Ib., Jahresb. Gymn. Saarbr., 16; — Ib., Faun. saraep. foss., i, 16, taf. 2, fig. 13; — Ib., Faun. saraep. foss., ii, 19, 51; — Gieb., Ins. Vorw., 316; — Bronn, Leth. Geogn., 3 aufl., I, ii, 683, tab. 9^3, fig. 15^a; — Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 288; — Roem., Leth. geogn., tab. 47, fig. 18; — Gein., Geol. Steink. Deutschl., 149.

The front wing has a very regular ovate form, and is broader in proportion to its length than any other species of Blattina, being only twice as long as broad; beyond the expanding base, the front margin is very gently convex, and the hind border, at first nearly straight, tapers considerably in the apical half; the apex is very broadly rounded. The veins originate in the middle of the wing, but all curve at first upward, and where the middle ones assume a general longitudinal direction, the externomedian is considerably above the middle. The mediastinal vein passes with a very slightly sinuate course to a short distance beyond the middle of the front margin, emitting five or more simple or simply forked oblique branches. Beyond the basal curve, the main stems of the scapular, externo- and internomedian veins are longitudinal, nearly straight, and parallel; the first terminates in the upper and the last in the lower part of the tip, leaving only the central part of the apical margin in the possession of the externomedian vein. The scapular vein branches from its base and emits about five branches which are generally simply forked, and the last of which runs parallel to the extremity of the main stem. The externomedian is forked before the middle of the wing, its branches approximate and simply or doubly

forked. The internomedian is scarcely arcuate, so that the area it covers narrows principally by the curvature of the margin; the vein emits four or five simply or doubly forked branches. The anal furrow is strongly arcuate on the basal, straight on the apical half, and terminates at the middle of the inner margin; the anal veins, eight or nine in number, are simple, parallel, and gently arcuate.

The single specimen of the wing known is blackish brown, perfect, excepting the extreme tip, the costal border distinctly marginate; the veins are distinctly pronounced, and the interspaces filled with delicate transverse veins, running from the veins and not meeting those of the opposite vein directly, but forming by their mode of union pentagonal, sometimes tetragonal, cells, which can be seen by the naked eye; those toward the apex of the wing being larger than the others. Length 39 mm., breadth 16 mm., or the breadth to the length as 1 : 2.4.

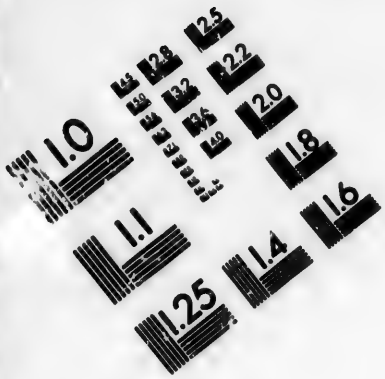
Goldenberg compared this species, which is of large size and one of the largest of the genus, with *Etobl. carbonaria*, but like the following species it is distinguished from other Blattinariae by the unusual breadth of the wing as compared with the length; and in this respect this species is the more remarkable, being only twice as long as broad; it is also readily distinguished from the following by the rapid narrowing of the mediastinal area, and by the brevity also of the same area.

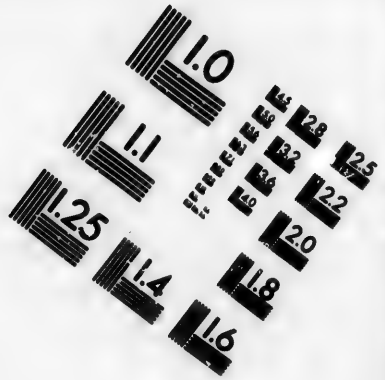
Several specimens have been found in the Auerswald coal-seam in Gersweiler near Saarbrücken, Germany. Upper carboniferous.

Etoblattina labachensis. Pl. 8, fig. 5.

Blattina anaglyptica var. *labachensis* Gold., Vorw. Fauna Saarb., 16; — Ib., Faun. saraep. foss., i, 16, taf. 2, fig. 15; — Ib., Faun. saraep. foss., ii, 19.
Blattina labachensis Gold., Faun. saraep. foss., ii, 51.

The front wing has a regular obovate form, a very little more than twice as long as broad, the sides nearly parallel. Beyond the base, the costal border is broadly convex, the inner border very nearly straight, the apex very regularly and broadly rounded. The veins originate near the middle of the wing and have scarcely any basal curve. The mediastinal vein is very long and scarcely sinuate, terminating beyond the middle of the apical half of the costal border, which is unusual in this genus; it emits a large number of generally simple or forked oblique branches, and is itself so far from the border as to make the area very broad, about one-third the breadth of the wing in the middle. The limit between the scapular and externomedian areas cannot be certainly determined, either from Goldenberg's illustration or description; but is probably, almost certainly, as marked in our plate, where the latter is exceedingly narrow, as in the preceding species, occupying the extreme tip; both the principal stems are longitudinal and straight, and both probably fork near the middle of the wing, to judge from the incomplete course of those given in Goldenberg's illustration, and the branches sometimes fork singly, all the forks having a longitudinal direction, parallel and close to each other. The internomedian bends a little from the longitudinal course of the other veins toward the inner border, while passing over the anal area, but beyond that is nearly longitudinal, scarcely arcuate, terminating only a little below the tip of the wing, making the internomedian area, like the mediastinal, of unusual length for a species of this genus, by which it seems to have some affinity to Gera-





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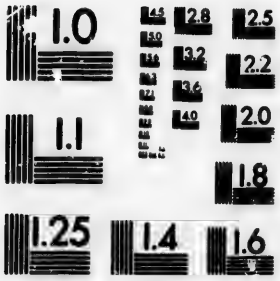

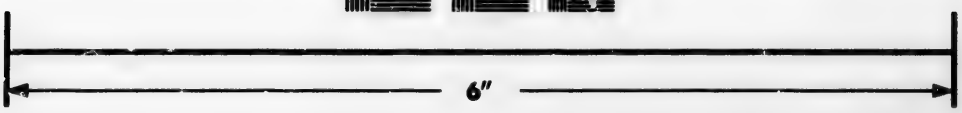

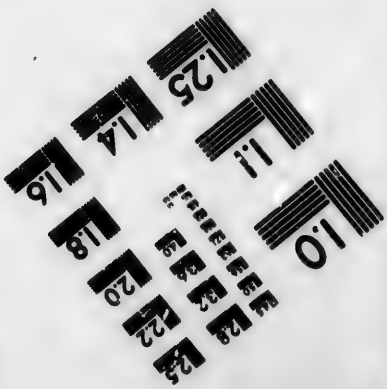

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blattina; the area is also of unusual equality, occupying like the mediastinal about one-third the breadth of the wing; the main vein emits four or five branches, which may be simple or forked, but all have a nearly similar oblique direction. The anal furrow is, apparently, not especially distinct nor marked as an arcuate vein, but is nearly straight, terminating at the middle of the inner margin, and, like the other anal veins, following the direction of the internomedian veins; as no mention is made of the innermost region of the wing by Dr. Goldenberg, perhaps his illustration is faulty at this point, as indeed it would be rather anomalous; more probably the species would not be found to differ greatly in this respect from the preceding.

This species has a brownish colour, and a delicate reticulation, formed on the same general plan as that of the preceding species. It is of comparatively small size, being 20 mm. long and 9 mm. broad, or the breadth to the length as 1 : 2.2.

It was at first considered a variety of *Etobl. anaglyptica* by Goldenberg, but afterwards separated by him. He noticed at the outset the smaller size and broader shape, but it also differs decidedly in general shape, in the far smaller extent of both the scapular and internomedian areas, the length of the mediastinal area, and the widely different distribution of the veins in the internomedian area. The breadth of the wing separates the species at once from all the other species of Etoblattina excepting the preceding, and it is also peculiar, as remarked, for the great length of the mediastinal and internomedian areas, although in the last point other species of Etoblattina equal it. It differs from the preceding species by its much smaller size, its broader tip, and the small extent of the scapular area.

Several specimens have been found in the coal shales of the Labach coal seam near Saarlouis, Germany. Upper carboniferous.

Etoblattina euglyptica. Pl. 2, fig. 16; pl. 4, fig. 7.

Blattina euglyptica Germ., Verst. Steink. Wettin, vii, 86–87, tab. 31, figs. 7^a, 7^b, 8; — Gieb., Ins. Vorw., 315; — Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 287; — Gold., Fauna saraep. foss., ii, 19.

Compare also the synonomy of *Etobl. Dohrnii, Gerabl. producta,* and *G. weissiana.*

The front wing is long and slender, having a very regular and rather strongly arcuate costal margin and a straight inner margin; the tip in the specimens known is broken, but there is no reason to suppose it to have been other than regularly rounded. The veins originate in the middle of the base, but immediately curve upward, so that the mediastinal area is narrow and equal, occupying about one quarter of the width of the basal half of the narrow wing, the main vein reaching somewhat beyond the middle of the wing, and emitting about nine oblique, simple branches. The scapular vein, curving somewhat strongly near the base, is beyond it nearly straight, rather distant from the mediastinal, and terminates at some distance short of the tip, commencing to divide at some distance before the middle of the wing, and emitting three or four long branches, which fork midway in their course, and are somewhat more longitudinal than the mediastinal branches. The externomedian vein is very similar to the preceding, and approximates it rather than the internomedian vein, while its course assumes the curve of the latter; it begins to divide at the middle of the wing, and emits three or four strongly divergent but nearly longitudinal branches, which fork again and occupy with these forks the entire apex of the wing, en-

croaching a little upon the costal and especially upon the inner margin. The internomedian vein is somewhat arcuate at the base, curving upward to above the middle of the wing, but afterwards extends to the inner margin in a nearly straight, arcuate course, terminating probably at some distance beyond the middle of the apical half of the wing, and emitting six or seven simple, oblique, straight, parallel and rather distant branches. The anal furrow is distinct, sharply arcuate, and terminates near the middle of the basal third of the wing, the four or more rather distant simple anal veins being subparallel to it but less curved.

Two specimens were described by Germar, both plainly belonging to the same species,[1] which is a large one, the wings measuring 10.5 mm. in breadth, and the longest fragment 31 mm. in length; the entire length was probably 33 mm., and the breadth to the length as 1 : 3.14. The specimens subsequently referred to this species by Goldenberg not only do not belong to it, but are referable to several distinct species (cf. *Etobl. Dohrnii*, *Gerabl. producta*, and *Gerabl. weissiana*).

Hind wing. One of the specimens figured by Germar has, besides the larger part of the left fore wing, broken fragments of the two hind wings, one of which, the left, we have reproduced on pl. 4, fig. 7. These show that the neuration of the hind wing was very similar indeed to that of the front wing. The mediastinal vein extended further toward the tip, but was somewhat similarly formed. The scapular vein had the same general arrangement and proportional extent. The same is true of the externomedian vein, excepting that the branches appear to be inferior instead of superior; but of the rest of the wing nothing can be determined; the interspaces throughout are of the same width. From the distribution of the veins it would appear as if the anal field were plicated, and this Germar asserts, but the fractured condition of the fossil does not allow of certainty, so far as the illustrations show.

It would appear from Germar's figure that there is some difference in the venation of the two wings; the mediastinal area appears much longer, for instance, in the right than in the left wing. On the right wing an additional principal vein, the marginal, extends down, next the costal margin, as far as the middle of the wing, but this portion is broken from the left wing.

This species is one of the largest of the slender forms of Etoblattina, the front wing having at the same time a more equal width than usual. In this particular it differs from the preceding species conspicuously; from *Etobl. affinis*, to which it appears to be most nearly allied, it differs in its very much greater size and in the more distant neuration. From *Etobl. Dohrnii*, which was referred to the same species by Goldenberg, it differs in the course of the mediastinal vein, which is parallel to the costal margin; probably also by the smaller extent of the internomedian area apically; and by the form of the wing, which has a more strongly convex costal margin, and especially an arcuate base which bends the roots of all the veins downward, instead of leaving them straight as in the latter species; it is also a little larger.

The two specimens come from Wettin, Germany. Upper carboniferous.

[1] Giebel says that the two fore wings figured by Germar "show some differences, whose meaning will only be understood when perfect wings are discovered"; but the differences are so very slight that they cannot have specific value.

Etoblattina affinis. Pl. 2, fig. 2.

Blattina affinis Gold., Neues Jahrb. f. mineral., 1869, 159, taf. 3, fig. 3;—Ib., Faun. saraep. foss., ii, 19.

The front wing is long and slender, straight and a little tapering beyond the base; both costal and inner margin are nearly straight almost to the tip, which is well rounded. The veins originate a little above the middle of the wing, and curve a little upward in passing from the base. The mediastinal vein is arcuate, subparallel to the costal margin and rather close to it; the area occupies one-fourth the breadth of the wing, and terminates at some distance beyond the middle of the wing, emitting a large number of oblique, generally simple, approximate branches. The scapular vein is also arcuate but much more gently, rather distant from the mediastinal before branching, and terminates just before the extreme tip of the wing; it commences to divide near the middle of the wing, and emits about five long, straight, simple or simply forked branches, closely approximate, and preserving very nearly the direction of those of the mediastinal area. The externomedian vein has a course very similar to that of the preceding vein, commencing to divide at nearly the same point, and emitting three or more compound or irregularly forking, closely approximate, longitudinal veins, occupying at their extremity a narrow area at the apex and the extremity of the inner margin of the wing. The internomedian vein is gently arcuate, having a nearly straight course from scarcely above the middle of the base of the wing nearly to the end of the inner margin, emitting a large number of slightly sinuate, subparallel, simple or simply forked branches, oblique toward the base of the wing, and gradually more longitudinal toward the apex. Anal area unknown.

The single specimen known is perfectly preserved, with the exception of the minor veins near the base of the wings and the anal furrow; it is a small species, being only 17 mm. long, and 5 mm. broad, and the breadth to the length as 1 : 3.4.

This species is one of the slenderest of the smaller species of Etoblattina, and is peculiar for the straightness and gently tapering form of the front wing; in its form it most resembles *Etobl. leptophlebica*, from which it differs a good deal in neuration, and especially in the lesser breadth of the scapular area and the less crowded disposition of the veins. Goldenberg considered it as coming between this species and *Etobl. anaglyptica*, but its much closer affinity to *Etobl. flabellata* must be conceded; from this species it differs particularly in its straight costal edge and its longer mediastinal area; it is also a slenderer species. From the species which precedes it it is sufficiently separated by its very much smaller size, as also by the straight costal margin.

One specimen. Löbejün, Germany. Upper carboniferous.

Etoblattina flabellata. Pl. 2, fig. 4.

Blattina flabellata Germ., Münst. Beitr. z. Petref., v, 92, tab. 13, fig. 4^a, 4^b;—Gieb., Deutschl. Petref., 637;—Heer, Viertelj. Naturf. Gesellsch. Zürich, ix, 287;—Gold., Faun. saraep. foss., ii, 19. (Not *Bl. flabellata* Germ., Verst. Steink. Wettin.)

Blattina anthracophila E. Gein., Neues Jahrb. f. Mineral., 1873, 694, taf. 3, fig. 2;—Ib., Verst. unt. Dyas Weiss., 4, taf., fig. 2. (Not *Bl. anthracophila* Germ.)

Compare also synonymy under *Gerabl. Münsteri.*

The front wing is long and slender, of only slightly unequal breadth, the costal border being gently convex and the inner border nearly straight until near the tip, while the tip itself is well rounded. The veins originate considerably above the middle of the base, and curve somewhat so as to be subparallel at first to the costal margin. The mediastinal vein is parallel to and not distant from the costal border, the area being less than one fourth the width of the wing, and terminates at or a little beyond the middle of the wing, emitting a considerable number of oblique, usually simple branches. The scapular vein is somewhat distant from the preceding and also runs very nearly parallel to the costal margin, along the base of the anterior third of the wing, terminating just before the tip of the wing; it commences to branch just as the mediastinal commences to bend toward the costal margin, and has four or five, generally simply forked, occasionally simple, branches, which have a direction very similar to that of the mediastinal branches, although much longer than they. The externomedian vein is rather strongly sinuate, commences to branch directly opposite the first dividing of the scapular vein, and emits at rather large angles four or five branches, which are usually forked once, but, in two of the specimens known, one of the forks of the second branch again divides; the branches occupy on the margin the entire apex of the wing, the main vein following very closely the course of the succeeding vein. The internomedian vein is also strongly arcuate, and beyond the middle of the wing assumes a more longitudinal course than before, extending the area very nearly to the extremity of the inner margin; toward the base this area, with the anal, occupies more than half the breadth of the wing, but it narrows rapidly beyond, and the vein emits a number of branches, the basal half of which are simple, straight, oblique, and comparatively distant, while the apical half of the same are simple or simply forked and considerably more longitudinal. The anal furrow is distinct, very strongly and regularly arcuate, and terminates at the end of the basal third of the wing; the anal veins are few, simple, similarly arcuate and parallel.

The species is a comparatively small one, the front wing measuring 15–17 mm. in length and 6–6.5 mm. in breadth, the breadth to the length being as 1 : 2.56. Geinitz describes his specimens as supplied with delicate cross-veins.

Germar described two species under this name, which I have of course retained for that bearing the earliest date, described in Münster's Beiträge. The other, described by Germar in his Carboniferous fossils of Wettin, is redescribed further on under the name of *Gerabl. Münsteri*, where also the points of departure will be noted. Dr. E. Geinitz, in his fossils of Weissig, has figured the present species with brief remarks, comparing it to Germar's *Bl. anthracophila*, and giving it that name in the explanation of the plate where it is figured; the points of resemblance pointed out by Dr. Geinitz are the simple character of the basal branches of the internomedian vein, the sudden assumption of a longitudinal direction of the same vein beyond the middle of the wing, and the simple character of the anal veins. With *Etobl. flabellata* he says it does not agree on account of the structure of the mediastinal area; but it is evident from this remark that he has compared it, not with the true *Etobl. flabellata*, but with *Gerabl. Münsteri*, and that his comparison is, therefore, in great measure justifiable. In all the points of his comparison with *Etobl. anthracophila*, however, it agrees even better with the true *Etobl. flabellata*, with which it also agrees in the distribution of the externomedian branches and in size, points in which it is at variance with *Etobl. anthracophila*. Had Dr. Geinitz compared his specimen with the illustrations

of Germar's species as given in Münster's Beiträge, he would certainly have come to a different conclusion.

As indicated above, the species is very closely allied to *Etobl. anthracophila*, from which it differs in the points mentioned, as well as in the greater narrowness of the mediastinal area, and in the less arborescent branching of the extremity of the internomedian area. From *Etobl. affinis*, with which it agrees in size, it differs in its rather shorter mediastinal area, the wider interspaces of the externomedian area, and in the shape of the wing, the costal margin of which is more convex and the whole wing not so slender.

Germar's single specimen came from Wettin, Germany. Upper carboniferous. The two specimens described by Geinitz, from the lower dyas of Weissig.

Etoblattina anthracophila. Pl. 2, fig. 1.

Blattina anthracophila Germ., Münst. Beitr. z. Petref., v, 92–93, tab. 13, fig. 3; — Ib., Verst. Steink. Wettin, 84 ("? = *Bl. anaglyptica*"); — Gieb., Deutschl. Petref., 637; — Heer, Viertelj. naturf. Gesellsch. Zürich, ix, 287 ("= *Bl. anaglyptica*").
Compare the synonymy of *Etobl. flabellata.*

The front wing is of medium size, rather slender and regularly tapering, both costal and inner margin very gently convex, the tip broken in the only specimen known, but probably rather contracted and well rounded. The base of the veins is not preserved. The mediastinal vein terminates a very little beyond the middle of the wing, and the branches, the apical ones at least, are tolerably distant, simple, and a little curved; the area is rather broad, occupying in the middle more than a quarter of the breadth of the wing, and narrowing throughout nearly the whole of the apical half; the basal half or more unknown. The scapular vein is very closely approximated to the mediastinal, begins to divide before the middle of the wing, or opposite the last branch of the mediastinal, and has an arcuate course beyond this, the convexity downward, and terminates a little before the apex of the wing; the branches are about six in number, having a direction parallel to those of the mediastinal vein, simple or forked (in the specimen cited, the first two are forked, the others simple), and the branched portion of the area occupies about one-third of the breadth of the wing. The externomedian vein is broadly sinuous, its curve in the fragment preserved, and the location of the other veins, indicating that it curved rather strongly at base; it commences to branch with the scapular vein and emits two or more very long branches, the first of which is compound and the second simple in the specimen; the vein occupies a long and very narrow area in the middle of the wing, and on the margin the entire tip and a portion of the extremity of the inner border. The internomedian vein is also sinuous, being at first probably arcuate, then straight and very gradually approaching the inner margin, until a short distance beyond the middle of the wing, when it assumes a longitudinal direction, and finally curves downward to the border in the middle of the apical fourth of the wing; it throws off a considerable number of veins, those emitted before it assumes a longitudinal direction being straight, oblique, simple and rather distant, those beyond being simple and compound, and rather closely approximated. The anal furrow is rather strongly and regularly arcuate, terminating at about the end of the basal third of the wing; the anal veins, about six in number, are simple and subparallel to the furrow.

The species is of medium size, the fragment of the single front wing which is preserved measuring 24 mm.; the length of the wing is probably about 25 or 26 mm.; the breadth is 9.5 mm. in the middle, making the length to the breadth as 1 : 2.7, but the breadth is probably a little greater toward the base.

After describing this insect in Münster's Beiträge, Germar concluded that it was probably the same as his *Bl. anaglyptica*, described in the same place, and subsequent authors have accepted this assumption, apparently without any special examination of the matter, with the exception of Dr. E. Geinitz, who has referred to this species a wing described by him from Weissig. *Etobl. anthracophila*, however, differs from *Etobl. anaglyptica* in several important points: the mediastinal area is a little shorter; the branching of the scapular vein more closely resembles that of the mediastinal, originates farther towards the middle, and is less arborescent, and the distribution of the externomedian branches is less regular; besides this the shape of the wing, and especially the curve of the costal border, is very different. The wing referred by Geinitz to *Etobl. anthracophila* is, however, to be considered as belonging to *Etobl. flabellata* and not to this species, for the reasons mentioned in the remarks here appended to the description of *Etobl. flabellata*. Our present species is indeed closely allied to the last named, but may be separated from it by the greater breadth of the mediastinal area, the approximation of the scapular to the internomedian vein, the greater narrowness of the scapular area, the greater marginal extension of the externomedian area, and the more arborescent branching of the internomedian veins in the outer half of the wing; it is also considerably longer. It is also somewhat larger than *Etobl. weissigensis*, which stands very close to it, and differs also by the tapering form of the wing, the larger marginal area of the externomedian area, and in the branching of the veins of the same area; this is both less regular and commences much further toward the base of the wing; at the same time the vein itself is much less sinuous than in *Etobl. weissigensis*.

The single specimen known comes from Wettin, Germany. Upper carboniferous.

Etoblattina weissigensis. Pl. 6, fig. 5.

Blattina weissigensis E. Gein., Neues Jahrb. f. Mineral., 1873, 692–94, taf. 3, fig. 1; — Ib., Verstein. unt. Dyas Weiss., 2–4, taf., fig. 1; — Ib., Neues Jahrb. f. Mineral., 1875, 6; — Ib., Neue Aufschl. Dyas v. Weiss., 6.

The front wing is long, slender and equal, the costal margin rather gently and very regularly convex, the inner margin straight with a very slight and very broad median excision, the apex well rounded, and almost produced. The veins originate from the middle line of the wing, and curve rather gently upward before assuming a nearly longitudinal direction. The mediastinal is parallel to the costal margin, curving rapidly to meet it a little beyond the middle of the wing; the area occupies nearly a third of the breadth of the wing, and possesses comparatively few and very distant oblique branches, most of them rather deeply forked. The mediastinal vein is in close contiguity to the mediastinal, is also parallel or subparallel to the costal margin, and beginning to branch where the mediastinal begins to curve toward the margin, emits a considerable number (about seven) of rather crowded branches, most of which are simple, gently arcuate or sinuous, and while less oblique than those of the mediastinal area, are similar in distribution; in the single specimen known the first of the branches is compound, the rest simple; the vein terminates just before the tip. Beyond the basal curve the externomedian vein is straight until it branches, a little beyond

the middle of the wing; beyond this it emits two or three sometimes forking branches, which are longitudinal and nearly approximated, so that the marginal extent of the area is very slight, occupying only the very tip of the wing. The internomedian vein, running contiguous with the preceding in the basal curve, parts rather rapidly from it, being directed at first toward the middle of the outer half of the inner border in a nearly straight course, until opposite the branching of the externomedian vein, when it assumes a slightly arcuate, longitudinal direction, and terminates just behind the tip of the wing; in the middle of the wing it is therefore very distant from the externomedian vein, which it afterwards rapidly approaches; in the basal portion, the distribution of the veins is very similar to that of the scapular area, but they are distant; beyond they are more frequent and arborescent, the branch originating at the point of change in the main vein, emitting a compound branchlet, which repeats the distribution of the branches of the main vein beyond it. The anal furrow is distinct, strongly arcuate, somewhat bent in the middle, rather distant from the internomedian vein and its first branch, and terminates at the end of the basal third of the wing; the anal veins are frequent, simple, arcuate and parallel to the furrow.

The wing is of rather small size, being 19 mm. long, and 6 mm. broad, or the breadth to the length as 1 : 3.17; the veins of the middle of the wing are very sharply defined, and the surface is delicately granulate.

Dr. Geinitz compares this species with *Etobl. anaglyptica* and *Etobl. leptophlebica*, and in a secondary way with *Bl. affinis*. It is indeed related somewhat closely to these species, and especially to the first named, and in form resembles best, though not very well, the two last named; but in essential features it has closer affinities with *Etobl. anthracophila*, which is somewhat larger than it, and is otherwise distinct from it by its general form and by the distribution of the branches of the externomedian vein, which divides much nearer the base, and occupies a larger marginal area than in *Etobl. anthracophila*; the branches of the basal portion of the internomedian vein are also much closer together in the same species.

The single specimen described by Geinitz came from Weissig, Saxony. Lower Dyas.

Etoblattina Dohrnii. Pl. 2, fig. 5.

Blattina euglyptica pars Gold., Neues Jahrb. f. Mineral., 1869, 162–63, taf. 3, fig. 8 (nec 9).

Not *Bl. euglyptica* Germ.

Compare also synonomy of *Gerabl. producta.*

The front wing is of a very regular shape, the tip being well rounded, and the upper and lower halves almost exactly alike in form, the costal and inner borders gently convex; the wing is largest in the middle, scarcely tapers toward the base, but more rapidly toward the tip, and especially near the apex. The veins originate together considerably above the middle of the wing, and have scarcely any, if any, basal curve. The mediastinal vein is straight, and terminates a little short of the extremity of the middle third of the wing, and emits, mostly from near its origin, half a dozen very long and unusually longitudinal simple veins; next the base the area occupies nearly one-third the breadth of the wing, and it tapers very gradually on its apical half. The scapular vein is also nearly straight, curved upward toward the costal margin only near the tip, and terminates just before the apex of the wing; it runs parallel to the costal margin along the middle of the anterior

two-thirds of the wing, commences to divide before the middle of the wing, and emits only two or three simple or forked branches, having the course of the apical branches of the preceding vein. The externomedian vein takes a straight course nearly down the middle line of the wing, does not divide until past the centre, and then emits two or three compound or forking branches, which spread at a considerable angle and occupy the entire apex of the wing. The internomedian vein, scarcely arcuate throughout most of its course, and slightly more longitudinal toward the extreme tip, terminates on the inner margin just before the apex, opposite the extremity of the scapular vein, and emits only a few rather distant straight or occasionally forked branches.[1] The anal furrow is not very strongly arcuate, and terminates at about the end of the basal two-fifths of the wing; the anal veins, about five in number, are rather distant, similarly or less arcuate, mostly simple, or when forked, but slightly so.

The wing is of medium size, measuring about 26 mm. in length, and 10.5 mm. in breadth; or the breadth to the length is as 1 : 2.5.

The wing is peculiar for its symmetry of form, and the straightness and longitudinality of the veins, and particularly for the very longitudinal direction and basal attachment of the veins of the mediastinal area. It is not very closely allied to any species; from the true *Etobl. euglyptica*, which Dr. Goldenberg considered it to be, it differs in form and size, and in the branches of the mediastinal area; from *Gerabl. producta*, which Goldenberg placed in the same species, it differs in the brevity of the mediastinal area and the nature of the branches in the same, in the origin of the division of the externomedian vein, and in the gradual narrowing of the internomedian area. It is perhaps most nearly allied to *Etobl. weissigensis* and *Etobl. anthracophila*; from the former it is sufficiently distinguished by its form, as well as by the distribution of the apical branches of the internomedian area, and the great length of the branches of the mediastinal vein; from the latter by the nearly uniform breadth of the wing and the same peculiarities of neuration. I have placed the American *Etobl. Lesquereuxii* beside it, but it is not very nearly related, the branches of the mediastinal and also of the anal area being very different, while the whole wing in *Etobl. Lesquereuxii* is larger and much less bilaterally symmetrical.

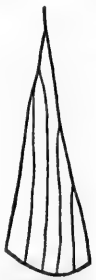
A single specimen is known, and was found at Wettin, Germany. Upper carboniferous.

Etoblattina Lesquereuxii nov. sp. Pl. 6, figs. 3, 4. (See also figure in text below.)

Front wing. This is long and slender, the costal margin very uniformly and considerably convex, the inner margin straight or scarcely convex, the whole wing nearly equal, the apical fifth tapering, the tip well rounded. The veins originate at about the middle line of the wing, the mediastinal and the united anal and internomedian in rather prominent ridges, the scapular and externomedian in a furrow between them; all together curve upward at first before assuming a more longitudinal direction, so that at the parting of the anal and internomedian veins, the anal area has more than half the width of the wing. The mediastinal vein runs subparallel to the costal margin, but continually and very gradually approaches it, much as in *Etobl. Dohrnii*, striking it at an unusually slight angle at a point a little beyond the middle of the wing; it emits about nine equidistant, and rather

[1] In my plate the anal furrow is incorrectly represented as being a forked vein; in reality the vein following the forked one is the anal furrow, so that there is one less vein in the internomedian area than is represented.

distant, simple, curving branches (the basal ones not represented on the plate), of which the basal ones are oblique while those beyond grow more and more longitudinal. The scapular vein runs very nearly parallel to the costal margin, most nearly approaching it where it first divides, a little beyond the end of the basal third of the wing, and then, passing in an arcuate course opposed to the curve of the costal margin, reaches the latter just before the apex of the wing; it emits about four branches, the terminal one simple, the others forked and the second even trebly, the general direction of all being less longitudinal than the apical branches of the mediastinal vein; at the widest the scapular area is two-fifths the breadth of the wing. Beyond the basal curve the externomedian vein is straight until it divides, at some distance beyond the middle of the wing, and up to this point it is unusually distant from the scapular vein on the one side and the internomedian on the other; at its division, that is, at the origin of its first branch, it turns abruptly but slightly downward, and runs subparallel to the apical portion of the costal border; its first branch is doubly forked, the offshoots inferior and thrown off at nearly equal distances from the origin to the tip of the branch; the two other branches of this vein are simple, longitudinal and nearly straight, the last arising before the end of the middle third of the wing, and the middle one midway between the first and third; all together occupy the entire tip of the wing; the origin of the middle branch being incorrectly given in our plate, a corrected figure of the apical half of the internomedian vein is here inserted. The internomedian vein is straight from a little beyond its separation from the anal to its last branch, and is thence feebly arcuate in a slightly more longitudinal course, terminating a little farther from the tip than the scapular vein; it emits four simple or forked, very distant, slightly arcuate branches; in the specimen upon which the description is based, the two middle branches are simple, the others forked. The anal furrow is very distinct, especially on the basal half, rather strongly and pretty uniformly arcuate, terminating at the basal two-fifths of the wing; the anal veins are numerous, being six or seven in number, and generally forked, often very deeply, and excepting the extreme short ones, are gently arcuate in the same sense as the furrow.



Etoblattina Lesquereuxii.

The wing is of medium size, being 25 mm. long, and 9 mm. broad, or the length to the breadth as 1 : 2.78.

It appears to present the under surface of a left wing, as the anal furrow is in relief. The principal veins and branches are also in delicate relief and distinct, excepting the anal veins. The surface of the wing is glistening and, excepting on the apical third, flat; toward the apex, and especially on the apical fifth, the interspaces are broadly furrowed, leaving the veins in sharp relief. In this part of the wing also, and indeed over nearly the whole surface, but less distinctly than here, the interspaces are broken by a delicate tracery of minute, irregular, pentagonal or rhomboidal cells, changing toward the base to a series of closely approximate, obscure, transverse lines, at right angles to the neighboring veins, and often forking feebly.

In the extent and distribution of the branches of the scapular and externomedian veins, as well as somewhat in the form of the wing, this species resembles *Etobl. weissigensis*, but it differs very much from it in the nature of the mediastinal vein, besides being a much larger insect. It agrees best with *Etobl. Dohrnii* in size and in the general limitation of the

various areas, but the shape of the wing differs considerably, and the branches of the mediastinal vein arise at equal distances all along the principal vein; the anal area too is larger and more crowded with veins. From *Etobl. anaglyptica*, to which it is closely allied, it may be distinguished by the brevity, slenderness, and diminishing extent of the mediastinal area, as well as in the later division and more longitudinal direction of the externomedian vein. In the characteristics of the mediastinal and scapular areas and their relations to each other it resembles both *Etobl. affinis* and *Etobl. flabellata*, but it differs from both in the more apical division and different distribution of the externomedian branches. Finally it is readily distinguishable from the other American species of this genus, *Etobl. venusta*, in the nature of the mediastinal area, and the less arborescent distribution of the branches of the scapular vein.

The single specimen known was obtained by Mr. R. D. Lacoe; it is preserved on a piece of carbonaceous shale picked up near Pittston, Penn., in a pile of culm, and is considered by him as doubtless coming from the roof shales of the D seam of anthracite (of Prof. Lesley's classification). Middle carboniferous.

Etoblattina anaglyptica. Pl. 2, fig. 15.

Blattina anaglyptica Germ., Münst. Beitr. z. Petref., v. 02, taf. 13, fig. 2; — Ib., Verst. Steink. Wettin, vii, 84, tab. 31, fig. 4; — Gieb., Deutschl. Petref., 637; — Ib., Ins. Vorw., 314–15; — Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 287; — Gold., Faun. saraep. foss., ii, 19.

Compare also the synonymy of *Etobl. anthracophila* and *E. labachensis*.

The front wing is long and tolerably slender, the costal border strongly arched, while the inner border is straight; the tip is broken, but is probably well rounded. The veins originate at some distance above the base, and probably curve upward a little[1] at first. The mediastinal area is very narrow, occupying not more than one-quarter the breadth of the wing, the vein running subparallel to the margin and terminating beyond the basal three-fifths of the wing; it emits a large number of rather closely approximated oblique branches, mostly simple, occasionally forked. The scapular vein is somewhat distant from the mediastinal, and has a broadly sinuate course, terminating shortly before the apex of the wing; in the middle of the wing the area occupies considerably more than one-third of its entire breadth, and, commencing to branch as far back as the end of the basal third of the wing, it emits three or four, mostly forked, sometimes doubly forked branches, having a direction very closely parallel to the branches of the mediastinal vein. The externomedian vein, beyond its basal curve, is very nearly straight, and terminates at the extremity of the inner margin, so that just the whole apex of the wing is occupied by the externomedian area; it commences to branch at some distance beyond the preceding vein, but still much before the middle of the wing, and emits three longitudinal branches, each of which forks nearly opposite the origin of the terminal branch of the scapular vein, and most of the forks again divide halfway to the tip, the whole being very regularly disposed. The internomedian vein follows the straight course of the externomedian to a short distance beyond the middle of the wing, the area thus rapidly narrowing, and then takes a

[1] This does not appear so well in our plate as in the representation by Germar in his Wettin fossils.

longitudinal course, reaching the margin only far toward the apex; before this turn in its direction, the vein emits three or four straight branches, most of which are simple, but the last one emits on the outer side a compound branch somewhat similar to the arborescent division of the main stem at its bend, which fills the apical half or more of the area with dichotomizing veins. The anal furrow is distinct, strongly and regularly arcuate, terminating near the end of the basal third of the wing; on account of the anterior origin of the main veins at the base of the wings, the anal area is nearly as broad as it is long, and the anal veins, which are numerous and approximate, are arcuate, parallel, and mostly simple.

The wing is of medium size, being probably 26 mm. long (the fragment preserved has a length of 25 mm.), and is 10 mm. broad; or the breadth is to the length as 1 : 2.5. The representation on my plate gives it a very little too small, and especially too short.

Germar subsequently placed his *Bl. anthracophila* with this species, but wrongly, as I have endeavored to show in my remarks under that species. Goldenberg at one time considered *Hermatobl. labachensis* as a variety of this, but afterwards more correctly removed it from that category; for the principal distinction in this case also, see the remarks under that species. We have placed it between the two American species of this genus, not because it seemed most closely allied to them, but because their place in the series appeared to lie here. *Etobl. anaglyptica*, however, seems to be very closely related to *Etobl. venusta* in most of its features, but is smaller than it, has a proportionally smaller scapular field and a considerably larger externomedian field; the distribution of the apical branches of the internomedian vein is also more complex in this species than in *Etobl. venusta*; from *Etobl. Lesquereuxii* it is at once separable by the form of the wing and the greater breadth and extent of the mediastinal area. Among European species it is perhaps most nearly allied to *Etobl. mantidioides* and *Etobl. carbonaria*, but differs from both of them in much the same particulars as from *Etobl. venusta*; it is also larger than they, and especially than *Etobl. mantidioides*.

The single specimen comes from Wettin, Germany. Upper carboniferous.

Etoblattina venusta. Pl. 6, fig. 12.

Blattina venusta Lesq., Owen, 2d Rep. Geol. Ark., 314, pl. 5, fig. 11; — Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 287; — Scudd., Geol. Mag., V, 176–77; — Gold., Faun. sarnep. foss., ii, 19.

Front wing. The wing has an oblong subovate form, apparently resembling that of *Etobl. carbonaria*, so far as can be judged from the rather imperfect fragment which represents the American species; the costal margin, however, is nearly perfect, and is very regularly and considerably convex — more convex, perhaps, than in any other species of Etoblattina. Although the base of the single known specimen is broken, the veins by their curve appear to have arisen near the middle line of the wing, and to have been well arched in running from the base. The mediastinal vein runs subparallel to the costal margin, gradually approaching it in its apical half, and at last rather suddenly impinging on it, at about the end of the middle fifth of the wing; it emits an excessive number (sixteen or more) of mostly arcuate, simple or forked veins, closely crowded and subparallel, at base nearly transverse, at tip very oblique; in its middle the area is nearly one-fourth the width

of the wing. The scapular vein runs subparallel to the costal border and rather distant from it, but does not have a regular curve, for it divides not far from the end of the basal third of the wing, and turns from the original course as much as does the branch; it appears, therefore, to be formed of two stems, and each of these emits in a similar manner three branches, the first two forked, the last simple; the distribution of the branches of this vein is therefore arborescent, the veinlets being mainly longitudinal, and together occupying all the space beyond the mediastinal vein almost, if not quite, to the tip. The externomedian vein has a broadly arcuate course, the apical portion of which is nearly traight; it begins to divide near the middle of the wing, opposite the secondary forking of the scapular vein, and emits four straight longitudinal branches, which, if they fork at all, only do so next the apical margin; they occupy a very slender field on the apical margin, apparently more below than above the very apex. The internomedian follows closely the course of the externomedian vein, being nearly straight in its apical half, and terminates shortly before the tip of the wing, emitting eight or nine long, arcuate, generally simple, occasionally forked branches, the apical ones more longitudinally disposed than the others, and all tolerably close. The anal furrow is strongly arcuate, and strikes the inner margin certainly before the middle of the wing, perhaps considerably before it; the few anal veins that can be seen appear to show that they are not very numerous and are arcuate next the anal furrow.

The wing is of a tolerably large size, the length of the fragment being 24.5 mm., the probable length of the wing from 28–30 mm., and the breadth of the fragment doubtless that of the whole wing, 12.75 mm.; the breadth to the length being about as 1 : 2.27. The upper surface of the wing is exposed, and is flat and admirably preserved; the veins at the base of the wing with their branches, as far as the forking of the scapular, are slightly raised; beyond this point, the principal veins, although elevated, are sulcate, and the branches of the mediastinal, scapular, and externomedian are feebly impressed, while those of the internomedian vein are slightly elevated; the anal furrow, in the part lying parallel to the first internomedian vein (the only part preserved), is impressed in its basal half, elevated in its apical half, and then indistinguishable in character from the first internomedian branch, excepting in being a little less sharply elevated and slightly broader; the cross veins are equally distinct or nearly so throughout the wing, and are slightly elevated, making a delicate tracery over the wings just indistinguishable by the naked eye; in the apical half of the wing they are nearly all straight and regularly transverse, but in the basal half, and especially in the central region of the wing, they are more sinuous and interlacing; this is especially true in the mediastino-scapular interspace, between the first and second branches of the scapular vein, and on either side of the externomedian vein where it first divides.

Although figured by Lesquereux nearly twenty years ago, this first known of American fossil cockroaches has never before been described, the remarks in the Arkansas report being only of a general nature. In the strongly curved outline of the costal margin, this species resembles *Etobl. anaglyptica*, with which it agrees also in the general distribution of the areas; it is undoubtedly more nearly related to this species than to any other, but differs from it in many minor points: the veins of the mediastinal area are much more frequent and crowded in *Etobl. venusta*; the branches of the scapular vein have a much more arborescent distribution, and its first branch has as many sub-branches as the main stem,

while in *Etobl. anaglyptica* it is only simply forked; the division of the externomedian vein commences farther from the base in *Etobl. venusta*, and the apical portion of the internomedian vein does not have a subarborescent distribution as in *Etobl. anaglyptica*. In the form of the wings and the distribution of the scapular branches, it shows a certain likeness to *Etobl. mantidioides*, but its much greater size and more extensive mediastinal area readily separate it from that species. The points in which it differs from the only other American species of the genus will be found mentioned under *Etobl. Lesquereuxii*.

A single specimen only has been found, which lacks the base and tip, and has a ragged inner margin. It is doubtful whether the dotted line in Pl. 6, fig. 12, by which I have indicated the supposed outline of the base, is correct, for the curves of all the veins would seem to indicate that too much is represented as lost; but as this would represent an anal area of unusual brevity, I have only indicated in the measurements given above the possibility of an error in my delineation.

It comes from Frog Bayou, Arkansas, and was obtained by Prof. Leo Lesquereux in black carbonaceous shale, with broken fragments of plants, overlying the thin seam of coal between the millstone grit and the subcarboniferous limestones; and if the period of deposition of the millstone grit was the same in the eastern and western coal deposits (see the introduction), is the oldest, as it was the first discovered of the American fossil cockroaches.

Etoblattina mantidioides. Pl. 3, fig. 8. (See also the figure on the opposite page.)

Blatta sp. Kirkby, Geol. Mag., IV, 389, pl. 17, fig. 6, 7.
Blattidium mantidioides Gold., Faun. saraep. foss., ii, 20.

The single known specimen of this species is composed of only the basal half or more of a front wing, so that it is impossible to give its shape with any certainty, or to be sure of the limit between the scapular and externomedian areas. The costal margin is regular and rather gently arcuate, and the inner margin, beyond the basal curve, is straight. This is inaccurately given in our plate as curved like the costal margin, and the terminal portion has therefore been incorrectly restored; it is far more probable that the shape of the wing was much as in *Etobl. carbonaria*, and a corrected figure is therefore given on the opposite page. The veins originate above the middle of the base of the wing, and have a gentle basal curve. The mediastinal vein is very short, almost reaching the end of the fragment, which certainly does not represent more than one-half of the costal border; it runs parallel to and not distant from this border, the area occupying less than a fourth of the breadth of the wing; it emits five or six simple or forked, parallel, oblique branches. Between the mediastinal and internomedian areas, near to the base of the wing, are three veins; whether the middle of these belongs to the upper or lower — *i. e.*, the scapular or externomedian — cannot be told from the broken specimen; it appears, however, to branch from the scapular, and this I deem to be the most probable relation of this vein, although it is otherwise indicated on the plate by the mark at the border; for on first study its approximation, toward the end of the fragment, to the internomedian vein seemed to render this its probable relation, and to make me then conclude that its basal union with the scapular was only apparent; subsequent study, especially in comparison with the species to which it appears most nearly allied, has since made the opposite appear the truth; and while one cannot be certain of one's ground with so imperfect a fragment, the comparison of this fragment with the more perfect relics of the species near which I have now placed it will convince any one, I think, that its true affinities are here, and that the middle main

branch probably belongs accordingly to the scapular vein. Supposing this to be so, the scapular area is very extensive, terminating probably at or scarcely above the tip of the wing, and occupying in the middle of the wing nearly half its width; the vein branches very near the base, and each branch divides dichotomously several times, sending forth longitudinal shoots, which in the upper branch at least show, by a certain obliquity, signs of a similarity to the veins of the mediastinal area. The externomedian vein branches dichotomously like the lower branch of the scapular vein, commencing a little before the middle of the wing; the branches approximate, at least at first, but afterwards probably spread in more or less of a fan shape. The internomedian vein is gently oblique and very slightly sinuous, and, to judge by its assuming toward the end of the fragment a more longitudinal direction, probably terminates far out on the inner margin toward the tip of the wing, the area occupying nearly half the breadth of the wing at the middle; it emits a number of parallel, oblique, forked, rather distant branches. The anal furrow is strongly and regularly arcuate, terminating at not far from the end of the basal third of the wing; the anal veins are rather numerous, subparallel, nearly straight and usually forked, the forks sometimes terminating on the neighboring veins or on the anal furrow, and so presenting a confused appearance.

Etoblattina mantidioides.

In addition the wing is described as having the front margin produced and flattened. The fragment is nearly 11 mm. long, representing a wing of comparatively small size, probably about 18 mm. long; the breadth is about 8 mm.; the restored portion in the plate is represented as much too short, the breadth to the length being about as 1 : 2.25. The annexed cut is more nearly correct in this particular. Besides the single specimen described, another fragment, showing one or two veins only, occurred with it, and probably belongs here, for both are similarly marked by a fine and irregular reticulation.

If we have correctly interpreted the parts of this wing, the species is somewhat closely allied to *Etobl. carbonaria*, although certainly distinct from it by the brevity of the mediastinal area and the different distribution of the branches of the scapular vein. In the brevity, although not in the width of the mediastinal area it approaches *Etobl. leptophlebica*, but the wing does not appear to be so slender, and the distribution of the branches of the scapular vein is again different; from *Etobl. russoma*, with which it agrees in general features, it differs in its smaller size and the brevity of the mediastinal area; while from *Etobl. flabellata*, with which it agrees very well in the extent of the mediastinal area, it differs by the very different distribution of the branches of the externomedian vein.

The single specimen came from "the north bank of the Wear, opposite to Claxheugh, about two miles from Sunderland," Durham, England; from "very near to the top of the coal-measures, as developed in Durham." Upper carboniferous, according to the recent classification of Hull.

Etoblattina carbonaria. Pl. 2, fig. 3.

Blattina carbonaria Germ., Verst. Steink. Wettin, vii, 85–86, tab. 31, figs. 6ª, 6ᵇ; — Gieb., Ins. Vorw., 315; — Heer, Viertelj. naturf. Gesellsch. Zürich, ix, 287, No. 3 (not 288, No. 15); — E. Gein., Neues Jahrb. f. Miner., 1875, 5; — Ib., Neue Aufschl. Dyas v Weiss., 5; — Gold., Faun. saraep. foss., ii, 19, No. 3 (not 20, No. 34).

The front wing has a somewhat obovate form, the costal border being very regularly and rather strongly convex; the tip is broken in the single specimen known, and the inner

border is not continuous, so that its contour cannot be certainly determined, but it appears to be gently convex. The veins start from some distance above the middle of the wing, and curve upward considerably before assuming a longitudinal course. The mediastinal vein continues subparallel to the front border, and terminates scarcely before the middle of the apical half of the wing, emitting seven or eight very oblique, usually forked branches; the area is narrow, scarcely occupying one-fourth the breadth of the wing. The scapular vein has a sinuous course, diverging slightly from the costal margin and from the mediastinal vein in the basal half of its course, afterwards converging and terminating barely before the tip of the wing;[1] it commences to divide far before the middle of the wing, and anterior to several branches of the mediastinal vein; its branches are numerous (seven or more), and simple or forked, having in this respect as in direction, although not at all in length, a resemblance to the mediastinal branches; the mediastinal area occupies two-fifths the breadth of the wing. The externomedian vein beyond its basal curve is nearly straight, and terminates at some distance before the end of the inner border, so that the area occupies rather broadly the lower outer angle of the wing; the vein commences to branch a little beyond the middle of the wing, and emits three or four simple or compound branches, which, like those of the preceding areas, are pretty closely crowded. The internomedian vein follows closely the course of the externomedian, so that the area narrows regularly and rather rapidly; the vein emits six or seven simple or simply forked branches, which are pretty straight, oblique, and more distant than those of the other areas. The anal furrow is well impressed, strongly arcuate, and terminates near the end of the basal third of the wing, while the anal veins are subparallel to it, simple, and rather closely crowded.

This gracefully formed wing might well stand as the type of this group of fossil cockroaches; it is of medium size, the length of the fragment being 20 mm.; the probable length of the wing is 22.5 mm., and its breadth is 8.75 mm.; or the breadth to the length as 1 : 2.57.

The pronotal shield attached to the wings has a parabolic outline, the hind border, however, strongly convex; the broadest part is scarcely in front of the middle of the posterior half, where the breadth equals the length; in front of this it tapers rapidly. Length, 9.5 mm.

The wing has much the same shape as *Etobl. mantidioides*, from which it differs in its larger size, the greater length of the mediastinal area, and the distribution of the branches of the scapular and externomedian veins. It also approaches the American *Etobl. venusta*, which is larger than it, but agrees better in the mediastinal area, and to a large extent in the branches of the scapular vein; in *Etobl. venusta*, however, this first divides still further toward the base of the wing; and the branches of the externomedian vein are also simple in the American species and compound in the European. From *Etobl. didyma* it differs by its very much smaller size, the narrowness of the mediastinal area, and the distribution of the externomedian branches.

Germar described the species from seven individuals from Wettin, Germany. Upper carboniferous. Geinitz mentions a specimen from Weissig, Saxony. Lower Dyas. (But as no description or figure is given, this may be looked upon as dubious.)

Acridites carbonaria, referred by some authors to Blattina, appears to be a Neuropteron.

[1] The area of this vein is represented on our plate as broader than it should be, and the restored outline is also probably too contracted, throwing the extremity of the vein at the extreme tip of the wing.

Etoblattina didyma. Pl. 2, fig. 13.

"*Dictyopteris didyma* Rost, Dissert. flor. Wettin, 21."

Blattina didyma Germ., Münst. Beitr. z. Petref., v, 92, tab. 13, fig. 1[a]1[b]; — Ib., Verst. Steink. Wettin, vii, 83, tab. 31, figs. 2, 3; — Quenst., Handb. Petref., tab. 24, fig. 16; — Gieb., Deutschl. Petref., 637; — Ib., Ins. Vorw., 314; — Pict., Traité Pal., 2[e] éd., II, 362, pl. 40, fig. 2; — Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 287; — Ib., Faun. saraep. foss., ii, 19.

Not *Blattina*? *didyma* Germ., Verst. Steink. Wettin, vii, 87, pl. 31, fig. 10; nor *Bl. didyma* Gein., Neues Jahrb. f. Mineral.; nor *Blatta didyma* Germ.-Ber., Org. Reste Bernst., II, 34–35.

Compare the synonomy of *Anthracobl. sopita*.

The front wing is long and nearly equal, the costal margin regularly and considerably convex, the inner margin almost straight until near the tip, the apex broadly and regularly rounded. The veins appear to originate somewhat above the middle of the base, but about the middle line of the wing. The mediastinal vein runs parallel to the costal margin at about the middle of the anterior half of the wing, and terminates by a somewhat rapid curve upward at about the middle of the apical half of the wing; it emits a large number of not very closely crowded simple or forked oblique branches. The scapular vein, beyond its basal curve, has a nearly longitudinal course, but apically bends upward somewhat abruptly,[1] and terminates just before the tip of the wing; it first divides at about the end of the basal third of the wing; its first branch is compound, but the others, two or three in number,[2] are simple; the vein is very distant from the mediastinal, so that the area, at its widest, occupies nearly one-half the breadth of the wing. The externomedian vein also divides early, before the middle of the wing, and occupies with its branches the entire broad apex of the wing, and encroaches slightly on the inner margin; it emits first a compound arborescent branch, and then several simple branches, the latter terminating below the extreme apex. The internomedian vein, beyond its basal curve, is nearly straight, and terminates a little before the apex of the wing, emitting eight or nine simple or occasionally forked, somewhat sinuous, oblique branches, besides, in the only example known, a single superior branch parallel to the main vein.[3] The anal furrow is well impressed, strongly oblique, and terminates at the end of the basal third of the wing; the numerous anal veins which follow it are similarly but more gently curved and simple or forked.

The wing figured by Germar is a little broken at the base, but otherwise nearly perfect, for although the apical margin is represented as doubtful by Germar, its agreement with the tips of the veins renders it almost certainly correct; the wing thus preserved is 40 mm.

[1] This is the way it is represented in Germar's larger and presumably more correct figure in his Wettin fossils; in his smaller figure it has no such abrupt bend.

[2] Different in the several figures by Germar.

[3] It is impossible, from Germar's figures, to be quite sure that the lowest two or three branches of the externomedian vein do not belong to this superior branch of the internomedian vein, which latter would then have the peculiar disposition common to *Etobl. anaglyptica* and other allied forms; but the mode of distribution of the branches of the main internomedian vein beyond the origin of this superior branch is very regular, while in all those species in which the internomedian vein changes from an oblique to a longitudinal course and is accompanied by an arborescent disposition of the apical branches, this portion of the area is either itself filled with similar arborescent branches, or is at least irregular. In his description Germar also assigns these doubtful branches to the externomedian and not to the internomedian vein, and we may therefore reasonably follow the same course.

long and 15 mm. broad,[1] and is therefore the largest, or one of the largest, of the species of this genus; the breadth is to the length as 1 : 2.67; with a lens the entire surface is seen to be covered with a delicate network of cross veins, connecting the veins by exact transverse lines.

The two species to which this insect is the most nearly allied are those between which it is here placed. From both it is at once distinguishable by its far greater size; from *Etobl. carbonaria* it differs in the less extent of the scapular area, the fewer number of veins in the same area, and its earlier division. From *Etobl. russoma* it is separated by its narrower and longer mediastinal area, and the less profuse branching of the scapular and externomedian veins.

Germar described the species from a single specimen and its reverse, found at Wettin, Germany. According to Mahr, the species has been repeatedly found at Manebach, near Ilmenau, Germany. Upper carboniferous.

Acridites carbonaria, considered by some authors as the hind wing of this insect, is rather to be looked upon as neuropterous. *Blatta didyma* Germ.-Ber., is an amber insect, which does not belong to the Palaeoblattariae.

Etoblattina russoma. Pl. 2, fig. 6.

Blattina russoma Gold., Neues Jahrb. f. Mineral., 1869, 159, taf. 3, figs. 2^a, 2^A, 2^B; — Ib., Faun. saraep. foss., ii, 20.

The front wing is tolerably broad, the costal margin very regularly and rather strongly convex, the inner margin nearly straight to the tapering, well-rounded tip. The veins originate far above the middle of the wing, and have a slight upward curve for a short distance. The mediastinal vein runs subparallel to the costal border, which it approaches apically in a very gradual manner, and terminates shortly before the end of the middle third of the wing; the area is less than one-fourth the breadth of the wing, and is filled with seven or eight simple or forked, straight, oblique branches. The scapular vein has a broadly but rather strongly sinuous course, running parallel to the costal margin in the basal two-thirds of the wing, and beyond that curving toward the margin, terminating just before the tip; it begins to divide in the middle of the basal half of the wing, and emits about five branches, which become less and less compound apically, but terminate on the margin in about a dozen closely crowded branches; this area occupies more than one-third the breadth of the middle of the wing. The externomedian vein is broadly and rather strongly arcuate next the base, afterwards nearly straight, terminating at some distance before the end of the inner border; it commences to divide at some distance before the middle of the wing, but further out than the scapular vein, and bears a couple of compound branches, which subdivide irregularly many times, and fill with numerous veins an area larger than usual in this genus, occupying upon the margin not only the whole of the apical border, but an equal extent of the extremity of the inner border. The internomedian vein is parallel and close to the externomedian vein throughout its course beyond the basal curve, and emits about half a dozen long, generally simple and nearly straight branches, parallel to and rather distant from one another; so rapid is the narrowing of the

[1] Germar gives the measurement as 30 mm. long and 10 mm. broad; but evidently by mistake, as it disagrees both with the dimensions of his unenlarged figure and his German measurements (18 lines long by 6 lines broad); these latter are also inaccurate, as the wing is not three times as long as broad. The figures we have taken are from measurements of the smaller figure in the Wettin fossils.

area, that its length along the inner margin is only a little longer than its longest basal branch. The anal furrow is strongly impressed and its basal two-thirds very strongly arcuate, while the apical third is straight, terminating some distance before the middle of the wing; the anal field, notwithstanding its unusual length, is almost as broad, and is filled with about eight arcuate, moderately distant veins, most of which are simple, those nearest the furrow subparallel to it, the others curved in an opposite direction.

The wing is peculiar for the prominence of the lower basal angle, which in nearly right-angled, and for the corresponding extent of the anal area; it is of medium size, measuring 25 mm. in length and 10.5 mm. in breadth, the breadth being to the length as 1 : 2.38. Only a single specimen is mentioned as having been found, which is perfect but for the obliteration of parts of one or two veins at the tip of the internomedian area.

Goldenberg compares this species to *Etobl. carbonaria*, remarking that it agrees best with it in size and shape, but must be considered specifically distinct on account of the peculiar venation of all the areas, and especially of the combined scapular and externomedian areas (Mittelfeld), which has nearly double as many branches as in *Etobl. carbonaria*; he also mentions the peculiar branching of the externomedian vein by which the vein, beyond its last fork, runs free to the margin, parallel to an offshoot from the last branch of the same vein; and also the shoulder at the base of the wing, which is wrinkled and projects as a sharp angle. Although certainly very closely allied to the species mentioned, *Etobl. russoma* differs further from it in the less frequent forking of the mediastinal veins, in the earlier division of the scapular and externomedian veins, the doubly forking basal branch of the former, the greater irregularity in the branching of the latter, and in the much more rapid narrowing of the internomedian field. It also differs a little in its greater size, but it is not true that the combined scapular and externomedian areas have nearly double as many branches as in *Etobl. carbonaria*; the broken tip of the latter will not allow us to determine just how many there are, but there is room for additional branches in the broken portion, and those actually visible are eighteen, against twenty-five at the very margin of *Etobl. russoma*; or if we take each vein separately, we find in the nearly perfect scapular vein of *Etobl. carbonaria* eleven branches, against twelve in *Etobl. russoma*; in the externomedian vein of the former, which is certainly very imperfect, seven veins, against thirteen in the latter—a difference which is nearly double, but which is unquestionably due, in part at least, to the imperfect state of the only known fragment of *Etobl. carbonaria*. From *Etobl. didyma*, *Etobl. russoma* differs in nearly all the points by which it may be distinguished from *Etobl. carbonaria*, and, besides, differs considerably from it by its smaller size and less symmetrical shape, and the more frequent division of the scapular and lower externomedian branches. From *Etobl. leptophlebica* it differs in its broader and rounder form, and the much smaller extent of the scapular and internomedian areas, as well as in the fuller expansion of the externomedian area.

A single specimen was found at Löbejün, Germany. Upper carboniferous.

Etoblattina leptophlebica. Pl. 3, fig. 9.

Blattina leptophlebica Gold., Neues Jahrb. f. Mineral., 1869, 158–59, taf. 3, figs. 1^a, 1^A; — Ib., Faun. saraep. foss., ii, 19.

The front wing is long and slender, tapering, and straight; the costal margin is very gently convex, the inner margin straight, but the tip of the only specimen is broken.

The veins originate considerably above the middle of the wing, and curve slightly upward from the base before becoming longitudinal. The mediastinal vein is gently arcuate, runs for a short distance parallel to the border, then curves gently toward it, and terminates at about the middle of the wing; the area occupies nearly one-third the width of the wing, and is filled with half a dozen forking, occasionally simple, oblique branches. The scapular vein, beyond the common clustering of the veins at the base, parts rapidly from the mediastinal, and pursues a broadly arcuate course, at first divaricating slightly from the costal margin and afterwards gradually approaching it, and terminates probably just before the tip of the wing; in the apical half of the wing it runs as far as the middle line of the wing, making the area of unusual width; it emits about eight singly or doubly forked branches (with occasionally a simple one), which are therefore long and closely crowded, and assume a direction parallel to the mediastinal veins and very similar; the branching commences in the middle of the basal half of the wing, as far back as the first division of the internomedian vein. The externomedian vein is nearly straight, but very gently and broadly sinuous beyond the basal curve, and terminates probably not far before the apex, leaving for the area a small marginal extent over the probably narrow apex and lower outer angle of the wing; notwithstanding the slenderness of the area, the vein commences to branch before the middle of the wing, and emits three or four simple or forked branches (most of them probably forked near the tip, which is broken), which have a longitudinal course. The internomedian vein runs side by side with the preceding, and emits first a series of comparatively distant nearly straight and simple veins, about four in number, which occupy about one-half of the rather gradually narrowing area; these are followed by a forked and then by a compound branch, whose forks fill the narrowing apex. The anal furrow is strongly impressed, stout, strongly and very regularly arcuate, and terminates at the end of the basal two-fifths of the wing; the anal veins are mostly simple, occasionally feebly forked, very numerous, and very crowded, especially away from the furrow; next the furrow they are rather gently arcuate, gradually becoming nearly straight or sinuous.

The wing is peculiar among its immediate congeners for its straight and tapering slender form, recalling exactly that of *Etobl. affinis*; it is also peculiar for the extreme breadth of the scapular area, due to the deep sinuosity of the scapular vein. It is a comparatively small species, the wing being probably only 19.5 mm. long (the fragment preserved measures 16.5 mm.), and is 7 mm. broad in the middle; or the breadth is to the length nearly as 1 : 2.8. To judge from Goldenberg's figures (he makes no mention of the fact), the base of the mediastinal area is obscurely striate longitudinally, and the rest of the wing, or at least around the anal furrow, very minutely and very obscurely reticulate, with three or four rows of polygonal cells in each interspace.

This species cannot be confounded with any other, for it is widely separated from all with which from its size and form it might be compared, by the broad scapular area, whose long branches simulate the distribution of those in the unusually short mediastinal area; it is most nearly allied to *Etobl. russoma*, where the general distribution of the branches in the much smaller scapular area is similar, as is also the early branching of this vein and the externomedian; but the form of the wing, the short mediastinal area, and the much narrower and more gently tapering internomedian area of *Etobl. leptophlebica* at once distinguishes it from *Etobl. russoma*. It was compared by Goldenberg to *Etobl. anaglyptica*, on account of the form of the wing, but besides differing considerably in the

points of neuration mentioned by Goldenberg, and by others, has a much less convex costal margin and a more regularly and gently tapering form.

The single specimen comes from Löbejün, Germany. Upper carboniferous.

Etoblattina manebachensis. Pl. 2, fig. 14.

Blattina manebachensis Gold., Neues Jahrb. f. Mineral., 1869, 160, taf. 3, fig. 4; —Ib., Faun. saraep. foss., ii, 19.

The front wing is long obovate, both margins being somewhat similarly curved, although the inner is more strongly and more regularly convex than the costal margin, the latter being straight in its middle half; the tip is neither broadly rounded nor produced; the veins originate slightly above the middle of the wing, and curve upward gently before becoming straight; beyond this they are all unusually straight. The mediastinal vein runs parallel to, and tolerably distant from, the costal margin in the basal half of its course, the area here occupying a little less than a third of the breadth of the wing; beyond, the vein gradually approaches the margin, meeting it only a little beyond the middle of the wing; it emits half a dozen or more simple or simply forked oblique branches. The scapular vein is very straight, scarcely curved at the extremity as it approaches the border, just before the apical margin of the wing; it runs subparallel to the costal margin, commences to divide at the end of the basal third of the wing, and has about five branches; the basal one compound, the next forked, and the others simple, all taking the course of the mediastinal branches, and together occupying an area from one-fourth to one-third the width of the wing. The externomedian vein commences to divide scarcely earlier than the scapular vein, and emits about as many branches, which are simple, straight and longitudinal for a long distance, commencing to divide only opposite the origin of the last branch, when they fork almost simultaneously, the first again dividing; the area occupied by them is very regularly wedge-shaped, and at the margin occupies the entire apex of the wing. The internomedian vein runs very close and parallel to the preceding vein, being arcuate at the base and beyond straight, meeting the lower border opposite the tip of the scapular vein; it emits seven or eight, generally simple, occasionally forked, nearly straight, parallel, oblique, and rather distant veins. The anal furrow is well impressed, strongly arcuate, but straightened apically, striking the margin a little beyond the basal third of the wing; the area covers about two-fifths of the width of the base of the wing, and is occupied by eight or nine simple or deeply forked veins, arcuate next the anal furrow, straight and crowded toward the inner angle.

The wing, by the similarity of its margins, differs from most Etoblattinae, *E. Dohrnii* alone resembling it closely; it is also peculiar for the extreme straightness of its principal veins. It is of medium size, the single specimen known being a perfect fore wing, 25.5 mm. long, and 10 mm. broad; or the breadth is to the length as 1 : 2.55. From *Etobl. Dohrnii*, which it so closely resembles in general form, and in the straightness of the veins, it is readily distinguished by the crowding of the branches, the brevity of the mediastinal vein, and the early division and numerous branches of the externomedian vein. It is larger than, and not so tapering as, *Etobl. leptophlebica*, besides being immediately distinguished by the straightness of the scapular vein. From *Etobl. elongata* it is abundantly distinct by its broader form, and by the straightness of the apex of the scapular vein. The straightness

of the veins will also distinguish it from *Etobl. anthracophila*, with which it agrees in many points. Goldenberg compares it to *Etobl. primaeva*, with which it has certain resemblances indeed by the straightness of the veins, and the early division of the externomedian vein, but from which it differs in nearly every other point of its structure, and from which it may be distinguished at a glance (to mention no other points), by having scarcely one-half the breadth of the larger species.

A single specimen from Manebach, near Ilmenau, Germany. Upper carboniferous.

Etoblattina elongata. Pl. 2, fig. 10.

Blattina sp. ("cf. *Mahri*") E. Gein., Neues Jahrb. f. Mineral., 1875, 5, taf. 1, fig. 2;—Ib., Neue Aufschl. Dyas v. Weiss., 5, taf. 1, fig. 2.

The front wing is so imperfect in the only specimen known, that it is difficult to describe its form; yet to judge of the apical half, which only is preserved, it is the very slenderest of the species of Etoblattina, although nearly as long as the largest; the two margins approach each other gradually and equally in this apical half, making the tip exceptionally narrow, although it is well rounded. Only the tip and a portion of two branches of the mediastinal vein can be seen, by which we should judge that the vein was rather long, terminating only a little before the apical third of the wing, and had a number of rather distant, straight, oblique and simple branches. The scapular vein runs parallel to the costal margin until close to the tip, when it curves toward the margin, which it strikes scarcely before the extreme apex of the wing; it begins to divide near the middle of the wing, emits half a dozen straight, oblique, simple, rather distant branches, quite parallel to those of the mediastinal area, and occupies near the middle two-fifths, next the apex one-half, the width of the wing. The externomedian vein divides opposite the division of the scapular vein, the forks parting but slightly and again dividing (doubly) only shortly before the tip, so that this vein is unusually distant from the veins on either side of it, and occupies on the margin a narrow area, including most of the tip and the apical portion of the inner border. The internomedian vein probably changes its early course (after being directed, in the unknown basal half, more obliquely toward the inner margin), for the portion in the apical half is nearly longitudinal and nearly straight, curved downward toward the border very slightly; it terminates at a little distance before the tip, and emits two or three extremely distant simple branches.

Geinitz describes the surface of the wing as delicately granulate, and apparently of a somewhat rigid, parchment-like consistency. The fragment is 18.5 mm. long, and 11 mm. broad; the whole wing was probably 35 mm. long and scarcely more than 11 mm. broad, the breadth to the length being as 1 : 3.2; it is, therefore, the largest of the slender, or the slenderest of the larger species, and is peculiar for its tapering apex. In the straightness of its veins it resembles the preceding species as well as *Etobl. Dohrnii*, but is abundantly distinct from either by its slenderer form. The only other species which has such a tapering tip is *Etobl. parvula*, a much smaller and less slender form. Geinitz considered it as probably the apex of the wing of *Gerabl. Mahri*; the infrequency of the branches indeed make it resemble that species in a general way, but it is difficult to compare it with that from the fact that the only specimen of *Gerabl. Mahri* known has lost almost the whole of the tip; but there is a single point which is indisputable, and that is the excessive length

of the mediastinal vein in *Gerabl. Mahri*, which reaches the apex where that of the scapular vein impinges on the border in *Etobl. elongata*; it is, therefore, plainly impossible that they should be properly considered the same.

A single specimen is mentioned by Geinitz from Weissig, Saxony. Lower Dyas.

Etoblattina parvula. Pl. 2, fig. 9.

Blattina parvula Gold., Neues Jahrb. f. Mineral., 1869, 161, taf. 3, fig. 6; — Ib., Faun. saraep. foss., ii, 19.

In form the front wing of this species agrees pretty well with that of the last, but it is not so slender; both costal and inner margins have a similar and pretty strong convexity, and the wing tapers rapidly and pretty regularly to a somewhat pointed tip, the very apex of which is rounded. The veins spring from a common point, above the middle of the base of the wing, and have scarcely any basal curve. The base of the mediastinal area is, therefore, about one-third as wide as the wing at that point, and the mediastinal vein, very gradually approaching the costal margin, strikes it nearly at the end of the middle third of the wing; it emits half a dozen or more simple, oblique, slightly arcuate branches. The scapular vein is nearly straight, curving only near the tip, and, running subparallel to the costal margin, occupies with its branches a variable width of the wing, reaching the middle line in the apical half; it commences to divide at some distance before the middle of the wing, and emits about half a dozen simple, straight branches, the first one of which is forked near the tip, and all have a direction similar to, but a little more longitudinal than, the mediastinal branches; the vein terminates exactly at the apex of the wing. The externomedian vein, emitting near the middle of the basal half of the wing a straight, apically forked branch, which runs close and parallel to the scapular vein, itself bends downward, and then turns out again, and continuing nearly parallel to its first branch, ends some distance beyond the middle of the apical half of the inner border, emitting a couple of equidistant, straight and simple branches on the way; on the border, then, this area occupies the apical fifth of the inner margin. The internomedian vein runs in close proximity to the last vein, and has, therefore, a rather deeply sinuous course, and emits three or four, basally curved, apically forked branches. The anal furrow is very deeply impressed, strongly arcuate, terminating near the end of the basal third of the inner border, and leaving the area nearly as broad as long; the anal veins of the upper half of the area are obscured; in the lower half they are thickly crowded, nearly straight, unusually longitudinal and deeply forked.

This is one of the very smallest species, the front wing measuring only 9 mm. in length, and 3.75 mm. in breadth, the breadth being to the length as 1 : 2.4. In its minute size it differs from all but the succeeding species, which agrees well, as Goldenberg remarks, with that of the living *Ectobia lapponica* (Linn.); but it is peculiar, among palaeozoic cockroaches, for the shape of the wing and the distribution of the branches of the lower veins of the wing. It is most nearly related to *Etobl. elongata*, which is many times its size and is a slenderer species. It agrees in size with *Etobl. insignis*, but the course of the internomedian vein is very different, and all the veins and their branches are distinct instead of being nearly obliterated, as in that remarkable species.

A single specimen from Löbejün, Germany. Upper carboniferous.

Etoblattina (?) insignis. Pl. 2, fig. 7; pl. 4, fig. 9.

Blattina insignis Gold., Vorw. Faun. Saarbr., 17; — Ib., Faun. saraep. foss., i, 17, taf. 2, fig. 14; — Ib., Faun. saraep. foss., ii, 20, 51; — Scudd., Mem. Bost. soc. nat. hist., III, 19.

The front wing of this insect seems to have very nearly the same form as that of the preceding species, but has perhaps a little fuller anal area, and a less pointed tip. It is not at all clear from what point the veins originate, and it is doubtful whether they have a common origin. The veins are all exceedingly obscure, and even the limits of the areas are doubtful. The mediastinal area appears to have a width of one-third that of the wing at the base, and the vein seems to terminate at about the end of the middle third of the wing. The scapular vein is apparently nearly straight, running down the middle of the wing, and terminating at the tip. The externomedian probably occupies a narrow area; it can hardly divide before the middle of the wing, and on the margin covers the apical third of the inner border. The internomedian vein probably terminates at the end of the middle third of the wing, perhaps farther out, and is supplied with closely crowded forking veins. The anal furrow is deeply impressed, arcuate, and rather bent in the middle, and terminates at the end of the basal third of the wing. No branches of veins can be made out, to judge from Goldenberg's drawing, excepting in the internomedian area.

The two front wings are present in the only specimen yet discovered, one broken at the tip, the other along the inner margin; between these two the form of the wing can be accurately determined, but the tip is represented inaccurately in Pl. 2, fig. 7, as fully rounded, whereas its form should be much as in *Etobl. parvula*. With that species, it is the smallest known, the front wing measuring but 9 mm. in length, and 4.25 mm. in breadth, the breadth being to the length as 1 : 2.12.

Goldenberg remarks, that from the slight traces of the veins, the texture of the front wings of this insect was probably similar to that of those of Corydia and Phoraspis.

Hind wing. The hind wing of this species closely resembles the front wing in form and size, and could scarcely have possessed a plicated anal area; the neuration, too, is nearly as obscure as in the front wing, throwing some doubt upon the presumed thickened consistency of the front wing, since, in living insects, the hind wing is always membranous. In the original drawings of this insect, which formed the basis of Goldenberg's plates, and which Dr. Goldenberg has been kind enough to send me for study, the two hind wings are not quite alike, the left wing, which I have reproduced in outline in Pl. 4, fig. 9, being considerably more pointed and narrower than the right wing; the two wings show, also, a somewhat different arrangement of veins, although these are very obscure in both; next the front wing, which hides a portion of the costal area, there are in the left wing several longitudinal parallel veins, which cannot be made out in the right; and the rest of the wing, or fully two-thirds of it, is made up of a single longitudinal vein (the anal), with numerous obliquely longitudinal, simple branches; on the right wing, however, it would appear as if these branches, holding much the same position, were about equally divided between an anal and an internomedian set, in both of which they appear to be forked as often as simple; the arrangement faintly indicated on the right wing, corresponds better, although not closely, to that of the front wing. Goldenberg considers all the veins as

belonging to the anal field, which he describes as having "many delicate, radiating, longitudinal veins, connected by scarcely perceptible delicate cross veins." Length, 11 mm.; breadth, 4 mm.

This insect is, perhaps, the most complete of any of the palæozoic species of cockroach, the abdomen being almost completely preserved, but the legs unfortunately wanting. The pronotal shield is shaped somewhat as in *Etobl. carbonaria*, being longitudinally oval, broadest near the posterior margin, tapering toward the rounded front, the hind margin apparently broadly rounded; it is somewhat gibbous, and shows in the middle and laterally weak longitudinal furrows; it is 7 mm. long, and 6.25 mm. broad. The mesothorax is very short and inconspicuous; the metathorax quadilateral, nearly as long as broad, broadest in front, and narrowing rapidly behind; the front and hind borders are slightly arcuate, the curve opening posteriorly, the lateral angles rounded, the surface marked by weak median, longitudinal and transverse furrows; length, 2.75 mm., breadth behind, 2 mm. The abdomen is extraordinarily slender, as it is in no modern types, giving the insect a remarkably strange aspect; seven segments are preserved, and these grow gradually larger and broader posteriorly; they are sharply separated from each other, and the lateral margins somewhat upturned; the whole abdomen is 8.5 mm. long; its breadth at base is 1.6 mm.; at the end of the seventh segment 2.2 mm.

Goldenberg remarks of this insect, that it is by far the most complete and best preserved of all that have yet been found in the carboniferous formation (*Anthracobl. sopita* was not then known); and that it presents so many anomalies in not unimportant parts of its structure, separating it from all hitherto known cockroaches, whether living or fossil, as to render it highly probable that it should be considered a peculiar extinct genus, either belonging to the family of cockroaches, or falling very near it.

So little, however, is yet known of parts other than the wings in this genus, and as the wings *appear* by their neuration to fall within this genus, it has seemed the best way to place it here, at least until new examination shall give us a better clue to its true affinities. Should the neuration prove clearly distinct from the other members of this genus, there can be no doubt that it should stand by itself.

The single specimen found was discovered in a bluish shale, in the Skalley-shaft of the Hirschbach coal-pit at Saarbrücken, Germany. Middle carboniferous.

Archimylacris (*ἀρχή*, *μυλακρίς*)

Archimylacris Scudd., Daws. Acad. Geol., 2d ed., 388 (1868).

The mediastinal vein of the front wing runs parallel to and not distant from the costal margin to a little beyond the middle of the wing, occupying less than one-fourth the breadth of the wing, and emitting a considerable number of mostly forked, very oblique, but still short branches. The scapular vein is considerably and pretty regularly curved, in the same sense as the costal margin, but rather more strongly than it, lies rather distant from the mediastinal vein, and, beginning to branch at some distance before the middle of the wing, occupies with its branches, in the apical half of the wing, an average of nearly or quite one-half the breadth of the wing; its trend, however, is so far downward that, traversing the apex of the wing obliquely, it terminates below the tip; it emits a large number of branches, the general direction of which is similar to those of the mediastinal vein; they fork repeatedly, so that the area is closely crowded with veins. The externomedian

area is insignificant; the vein runs parallel to the preceding, forks a little way beyond it, the branches again bifurcating once or twice, all in a longitudinal way and closely approximated, so that at the extremity of the inner margin the area only covers a very limited space. The anal and internomedian areas together cover almost the entire inner margin, are very broad opposite the middle of the former, where they occupy considerably more than half the breadth of the wing, and rapidly and regularly diminish in width; the anal furrow is very strongly arcuate, rather distinctly impressed, and terminates at or a little beyond the end of the first third of the inner margin; there are six or seven simple or forked branches of the internomedian vein, nearly all of which curve a little outward as they approach the margin, and are more longitudinal toward the apex than toward the base. The veins of the anal area are five or six in number, more frequent toward the anal angle, nearly straight and oblique, and simple; excepting that next the anal furrow, which is arcuate, and emits two or three inferior branches, nearly parallel to the other veins.

The wings are peculiar for the backward sweep of the scapular vein, so that the entire apex is included in the area of this vein; the two species differ very much in the proportion of the length to the breadth, one being remarkably stout, the other a little more than usually slender.

Besides front wings, one of the species referred to this genus, preserves a fragment of the hind wing, and a pronotal shield; the former consists of the extremity of the costal margin, and simply shows a collection of closely crowded, forked veins, having a somewhat oblique direction, so nearly resembling those of the corresponding portion of the upper wing, by the broken tip of which they lie, as to appear at first sight as a continuation of them; the pronotal shield is attached to the wing, and is very regularly rounded, scarcely exhibiting the least angulation, somewhat broader than long, with a central circular depression.

This genus differs from Etoblattina in the character of the scapular vein and area, and in the narrow limits of the externomedian area; from Anthracoblattina, Gerablattina, Hermatoblattina, in the brevity of the mediastinal area, and the much greater development of the scapular area; from Progonoblattina in the very different distribution of the branches of the scapular vein, and the far greater extent of the internomedian area; from Oryctoblattina in the character or position of every area in the wing; and from Petroblattina in the distribution of the veins of the internomedian area and its slight importance.

The genus is confined to America, and is the only one of this group which has no European representatives.

Archimylacris acadicum. Pl. 6, figs. 8, 14.

Archimylacris acadicus Scudd., Daws. Acad. Geol., 2d ed., 388, fig. 153; — Ib., Amer. Nat., 1, 630, pl. 16, fig. 2; — Ib., Geol. Mag., v, 177.

Fore wing. The shape of the wing cannot be definitely determined from its imperfection; the costal margin, however, is very regularly and strongly convex, and all the veins are arcuate, arising apparently from about the middle of the wing. The mediastinal vein is subparallel to the costal margin, but a little less arcuate than it, probably occupies about one-fourth its width, and terminates at about the end of the middle fifth of the wing; it

emits a large number of oblique, generally forked, straight, and nearly parallel branches. The scapular vein is very strongly arcuate, parallel almost throughout to the costal margin, terminating beyond the apex; it is rather distant from the mediastinal and externomedian veins until it begins to divide, at about the middle of the wing; here, and a little further on, it sends forth a couple of compound branches, besides a short, apical, simple shoot; the earlier forks of the compound branches have a direction similar to the mediastinal veins, while the later are longitudinal. The externomedian vein follows closely parallel to the scapular vein, and emits only two branches, superior, simple, and nearly straight, near together, and only a little way beyond the branching of the scapular vein; consequently this area occupies only a narrow space at the extremity of the inner border; somewhat before the middle of the wing this vein is connected with those on either side of it by a pair of short, oblique, cross veins, having the same direction as the internomedian branches. The internomedian vein is even more strongly arcuate than the preceding, and very regularly curved; in the part which is preserved, and beyond the basal fourth, it emits four equidistant, nearly straight, parallel and oblique, simple branches (they are represented as too sinuous in the plate), and there are probably several others in the apical portion. The anal furrow is not deeply impressed, is very strongly and regularly arcuate, and probably terminates a little before the middle of the wing; there are half a dozen anal branches, mostly simple and oblique, and straight or arcuate, those next the furrow about as widely separated as the internomedian branches, the others more closely crowded.

The insect is of medium size, the wing being 23 mm. long, and the breadth of the fragment 10 mm.; probably the entire width of the middle of the wing, where it was presumably the widest, was 11.5 mm. and the breadth to the length as 1 : 2. The specimen is not very perfect, being partially overlaid by the frond of a fern, by which the lower apical half is obscured, excepting most of the longitudinal branches of the scapular and externomedian veins; the extreme base is also broken; if the upper surface is that exposed, it is a right wing; all the interspaces of the wing, excepting in the mediastinal area, are traversed by delicate cross veins closely approximated. The shape of the wing at once separates this species from *Arch. parallelum*.

The single specimen known was found by Mr. James Barnes, at the East River of Pictou, Nova Scotia, in shale overlying the roof of the main seam of Pictou coal. I owe an opportunity of examining it to Principal Dawson. Middle coal formation.

Archimylacris parallelum nov. sp. Pl. 6, fig. 6.

The fore wing is very equal, the larger part of both costal and inner margins being straight and very nearly parallel, the wing tapering only in a very slight degree until near the tip; the anal angle is broadly rounded, and very similar in this respect to the humeral lobe; the extremity of the wing is broken, so that the form of the wing cannot be stated; the veins originate a little above the middle of the base, and curve upward as they pass outward. The mediastinal vein runs subparallel to the costal margin, but gradually approaches it throughout (hardly so represented on the plate), until about the middle of the wing, when it curves rather rapidly to the border, terminating at some distance beyond the middle; it occupies less than a fourth the breadth of the wing, and emits, mostly in its outer half, five or six oblique, forked, or simple branches. The scapular vein, beyond its

strong basal curve, is straight, subparallel to, but a little divergent from, the costal margin, and terminates beyond the apex of the wing; it commences to divide a little beyond the basal quarter of the wing, and emits about seven longitudinal branches at subequidistant intervals; the first is compound, beginning to branch next the apical curve of the mediastinal vein; the others are simple or forked, or rarely doubly forked, and fill the apex and apical third of the costal margin with straight, crowded veins. The externomedian vein, beyond its basal curve, runs parallel to the preceding throughout, but before it forks, in the centre of the wing, is rather distant from both the scapular and internomedian veins; it emits three inferior branches, distant at their bases, the first two doubly forked, the last simple, the branches all closely crowded, as in the preceding area, and occupying rather less than the apical fifth of the inner margin. The internomedian vein, beyond its basal curve, is straight, only curving downward a little at the extremity, which reaches the border only just before the apical sixth of the wing; it commences to branch before the end of the basal fourth, and emits about seven branches, simple or forked, the basal ones transverse, oblique, and sinuous, the apical longitudinal, oblique, and nearly straight. The anal furrow is very deeply impressed and strongly arcuate, terminating before the basal third of the wing; the first of the anal veins is nearly as arcuate as the furrow, more distant from it basally than apically, and has a couple of branches; the others are generally simple, oblique, nearly straight, and crowded.

The insect is of medium size, the wing measuring, as preserved, 23 mm. in length, and 9.5 mm. in breadth; the entire length was probably 26 mm., and the breadth to the length as 1 : 2.74; only the tip of the wing is wanting, with the apical third of the costal margin. It is the upper surface of a right wing. The anal area, especially next to the furrow, is rather tumid, rendering the depth of the furrow much more apparent; on the contrary, there is a depression in the central parts of the humeral lobe; excepting the anal furrow, the mediastinal vein is more distinctly impressed than any; the branches of this vein, and those of the two following veins, as well as the veins themselves, are rather obscurely impressed, while the veins and branches of the internomedian and anal areas are delicately raised like tracery; the surface is very flat, and the whole is covered with an obscure network of polygonal cells of raised lines, which become more distinct in the anal and mediastinal areas, where they are mostly changed to transverse lines, frequently forking in passing from one vein to another, or uniting with the neighboring cross vein.

Hind wing. A fracture of the front wing, beyond the middle of the costal margin, with the removal of the parts beyond it, leaves exposed a fragment of the corresponding portion of the underlying right hind wing. Indeed, as I have proved by experiment, the upper wing may be peeled off from the lower; the piece broken off, carbonaceous in appearance throughout, represents not only the upper wing, but the film of detritus which lay between the two wings after deposition; for it shows upon the one side (the under) sharply raised, delicate lines, corresponding exactly in reverse to the sharply impressed veins of the under wing; while upon the upper surface are faintly impressed lines which are not opposite those on the other surface of the lamina, but represent the veins of the upper wing. The fragment of the hind wing thus exposed is very small, and covers the outer half or third of the costal border. The veins have the closest resemblance to those of the front wing, beyond which they lie, and almost appear as their continuation; the veins represented on Plate 6, fig. 6, above the mark separating, for the front wing, the mediastinal and scapular

areas, together with the vein next below it, are delicately raised, and probably represent the apical branches of the mediastinal vein of the lower wing, while all the others are distinctly impressed, and probably belong to the scapular vein. The former vein can be traced (but is not represented on the plate) for a short distance, through the thickness of the upper wing, running in a straight line toward the middle of that portion of the base of the wing which is covered by the prothorax.

Attached to the front wing is the pronotal shield, this being the only American fossil cockroach in which this part is certainly known. It is of a very broadly and transversely elliptical form, but, as preserved, does not have a perfectly regular outline, the curve of the left side being uniform, while that of the right side would place the broadest part of the shield a little behind the middle; with this exception it is extremely regular, either lateral or antero-posterior half being like its opposite. The surface is nearly flat and shows a centrally disposed circular or elliptical furrow, irregularly subparallel to the margin, enclosing a slightly convex central area, whose diameter is a little more than a third the breadth of the pronotum; the furrow is coarse and rather deeply impressed, but irregular from the irregularities of the stone; the posterior third of the shield is marked with faint, very closely crowded, minute, straight, transverse wrinkles, crossing the whole pronotum. Length, 7.5 mm.; breadth, 10 mm.

The parallel-sided front wing can by no possibility be confounded with that of *Archim. acadicum*, with its strongly convex costal margin; in this species the strongest part of the curve of the veins is close to the base, as in most palaeozoic cockroaches; but in *Archim. acadicum* it is at the middle of the wing, in conformity with its strong costal curve.

The single specimen was obtained by Mr. I. F. Mansfield, at Cannelton, Beaver county, Penn., in dark, sandy shale, immediately under the vein of Cannel coal referred to vein C of Professor Lesley. Lower coal-measures of Pennsylvania.

Anthracoblattina nov. gen. (ἄνθραξ, Blattina).

Blattina Auct (pars).

The mediastinal vein of the front wing runs parallel to and generally rather distant from the costal margin, terminating generally beyond, occasionally at the middle of the apical half of the wing, and emits a large number of oblique, parallel, seldom forking branches; the area generally occupies nearly one-third of the breadth of the wing. The scapular vein, sometimes curved near the base, is beyond that nearly straight, and terminates shortly before or at the apex of the wing,—in a single instance (*A. winteriana*) beyond it; it never branches more than once, usually not at all, before the middle of the wing, and the branches are usually longitudinal in appearance, although in all instances actually superior, and seldom assume the appearance of similarity to those of the mediastinal vein, as in Etoblattina; the branches are not numerous (more numerous in *A. spectabilis* than in the others), and seldom fork more than once; owing to the length of the mediastinal area, the space occupied by this vein and its branches is very restricted, although not more so than that occupied by the next vein. For the externomedian vein, which is separated from the preceding by an equal interspace, on either side of which the branches of the two areas diverge at equal angles, is usually a close counterpart in a reverse sense of the scapular vein, excepting that the first offshoot is usually more important than the others, often equalling, with its forks, the rest of the vein. The combined internomedian and anal areas occupy fully half the breadth of the wing near the base, and, excepting in

A. dresdensis, diminish in breadth more gradually than usual, the internomedian vein passing in a very gentle curve or a nearly straight line to a point on the inner margin usually beyond that to which the mediastinal vein reaches on the opposite border; it emits a large number (in *A. dresdensis* a small number) of either simple or forked, nearly straight veins, of about the same obliquity as those of the mediastinal area. The anal furrow appears to be tolerably well impressed, is rather strongly curved, and usually terminates a little more than one-third down the inner margin of the wing; the anal veins, about half a dozen in number, have a somewhat similar though slighter curve, are nearly parallel, some or all of them simple.

The wings are stouter than usual, only one of them coming up to the average of the whole group of Blattinariae, the average proportion of the breadth to the length in the genus being as 1 to 2.4.

Only one of the species of this genus shows anything besides the front wing; this single species is unusually perfect, showing the whole body and the legs as well as both pairs of wings. The body is very slender, but almost equally so, the abdomen being as wide as the rest, but much slenderer than is usual in modern types. The thoracic shield is longitudinally oval, and the legs are similar to those of modern types; whether or not they are spinous does not appear.

This genus is most nearly allied to Etoblattina, from which it differs principally in the greater size and much greater length of the medastinal area, and the lesser extent of the scapular area; from Archimylacris it is similarly separated, although in one species (*A. winteriana*) the termination of the scapular area is somewhat similar, owing to the peculiar conformity of the tip; from Gerablattina it differs in having the branches of the externomedian vein inferior instead of superior; and from Hermatoblattina in having those of the scapular vein superior and not inferior; from Progonoblattina it differs in the much more restricted extent of both the scapular and externomedian areas; from Oryctoblattina in the far less importance and very different nature of the scapular vein, and by the very different character of nearly all the other veins; and from Petroblattina in the nature and distribution of the veins in the externomedian area.

The species of this genus are altogether confined to Europe, so far as yet known.

Anthracoblattina spectabilis. Pl. 2, fig. 8.

Blattina spectabilis Gold., Neues Jahrb. f. Mineral., 1869, 161–62, taf. 3, figs. 7, 7ª, 7ᵇ; — Ib., Faun. saraep. foss., ii, 19; — ? E. Gein., Neues Jahrb. f. Mineral., 1875, 6; — ? Ib., Neue Aufschl. Dyas v. Weiss., 6.

Fore wing. Although the only described specimen of this species is very imperfect, its form is to a great extent known, excepting toward the base; the costal margin is regularly and strongly arcuate, while the inner margin is straight; and as the wing tapers rather rapidly in its outer half, the middle of the well-rounded tip is thrown considerably to one side of the middle line of the wing. The mediastinal vein runs parallel to the costal margin nearly as far as the middle of the wing, when it curves somewhat rapidly toward the margin and terminates at about the end of its middle third; the width of the area is about one-fourth that of the wing, and it is filled with numerous, rather crowded, simple or forked, oblique, straight branches. The scapular vein also runs parallel to the costal margin, and terminates on the apical margin just above the tip, and, being very straight in the apical

half of the wing, approaches the costal margin very gradually; it commences to divide before the middle of the wing, and emits at equidistant intervals half a dozen, simple or forked, straight and nearly longitudinal branches. The externomedian follows the course of the scapular vein, and begins to branch at the same point, emitting at unequal intervals four branches, which, with their offshoots, occupy the apex and very extremity of the inner margin of the wing; the first and last of these branches in the specimen described are compound, the others simple. The internomedian vein is gently and regularly arcuate, and emits, in the middle third of the wing, half a dozen branches, the basal ones of which are compound, the apical simple, and all nearly straight or slightly arcuate. The anal furrow is roundly bent where it parts from the other veins, and beyond that straight, probably terminating a little before the middle of the wing.

This insect is the largest of the palaeozoic cockroaches, the fragment measuring 43 mm. in length and 22 mm. in breadth; the probable length of the whole wing was about 54 mm., or the breadth to the length as 1 : 2.45. Goldenberg describes the surface as covered with a network of reticulations visible to the naked eye, which near the apex of the wing are formed of transverse, closely approximated, parallel cross-veins, broken into square cells by other fine lines; while at the base and in the middle of the wing they form an irregular tetragonal or pentagonal network.

This fine species has no rival in the genus excepting the next to be described, than which it is only a little larger. It differs from this, however, in the shape of the wing, which is much slenderer and has a less convex costal margin; it also has a proportionately shorter mediastinal area; from its size, it can by no possibility be confounded with any other species of the genus. Goldenberg compares it with *Etobl. didyma*, from which, as we have seen, it is generically distinct by the inferior origin of the externomedian veins; but, as he rightly says, it differs from that species in the distribution of the branches of each of the principal veins. Besides being peculiar for its great size, this species is marked by the crowded venation and by the comparatively conspicuous reticulation.

The specimen described came from Löbejün, Germany. Upper carboniferous. Geinitz reports the discovery of a specimen at Weissig, Saxony. Lower Dyas; but as he appends to it a query, it may be considered dubious until direct proof is given.

Anthracoblattina sopita. Pl. 4, fig. 8.

Blattina didyma E. Gein., Neues Jahrb. f. Mineral, 1875, 4–5, taf. 1, fig. 1; — Ib., Neue Aufschl. Dyas v. Weiss., 4–5, taf. 1, fig. 1. Not *Bl. didyma* Germ., for which see *Etobl. didyma*.

The fore wing is rather elongated, obovate, the costal border very strongly and regularly arched, the basal two-thirds of the inner margin almost straight, the tip well rounded; it is broadest in the middle, and narrows almost equally toward both extremities; the humeral lobe is greatly produced at the extreme base, by its sudden deflection to the root of the wing, forming a rounded subacute angle; the veins originate rather below the middle line of the wing, and curve strongly upward, following very closely the basal curve of the costal margin. The mediastinal vein runs parallel to the margin over nearly two-thirds of the wing, and then curving toward it, terminates rather beyond the middle of the outer half of the wing; it emits a large number, a dozen or more, of simple or forked, oblique, and considerably arcuate branches, tolerably distant from one another; the area occupies nearly

one-quarter the breadth of the wing in the middle. The scapular vein is differently represented in the two wings (of the same individual) figured by Geinitz; so differently indeed that both can hardly be correct, and for our description we have chosen the one which accords with the structure of the species evidently allied to this; in this it runs at first parallel to the costal border, as far as a little beyond the middle of the basal half of the wing, where it forks; its first branch is simple and continues in close proximity and parallel to the mediastinal vein, while it itself runs in a nearly straight, longitudinal course, terminating just before the extreme tip of the wing; it emits three other simple branches, the last one forking at the extreme tip, just beside an additional short apical branch of the main stem. The externomedian vein, more strongly arcuate next the base, divides a very little beyond the division of the preceding, and then runs parallel to that, emitting in all four branches, the first forking in the middle, the others simple; and all longitudinal, closely crowded, and together occupying an extremely narrow area on the margin at the extreme apex of the wing. The internomedian vein runs parallel to the preceding vein and its basal branch; but somewhat beyond the middle of the wing, emits a supplemental superior branch running nearly parallel to the main stem, and extending the area so much further out, that it terminates as near the apex as the scapular area, and narrows very gradually; commencing before the middle of the basal half of the wing it emits about eight nearly straight, slightly sinuous, oblique branches, the basal ones simply or doubly forked, the others simple, four or five of them emitted before the supplemental vein, the others beyond. Geinitz states, what his illustration bears out, that the second branch on this wing is forked only at the end; while in the opposite wing it is not only distinctly forked near the base ("nahe der Wurzel," but really at the end of its basal third), but one of the forks again divides at the tip. The anal furrow is rather deeply impressed on the arcuate basal half, lightly on the straighter apical portion, and terminates at about the end of the second fifth of the wing; the anal veins are arcuate, those next the furrow compound, the others simple, and all considerably and equally crowded.

Here again Dr. Geinitz's illustration is at fault, the two wings differing considerably, the anal area being undoubtedly too extended in the wing which we have not copied. Care seems to have been taken only with the wing which does not overlie the body; this is altogether unfortunate in illustrating an insect which is undoubtedly the most perfect example of a palaeozoic cockroach which has yet been found; and the chance to observe the differences between the two wings, as a basis for a distinction between individual and specific differences, is lost, excepting in the points actually specified by Geinitz; and as he particularly remarks upon the value of the differences observed by him, it is the more probable that the other differences, apparent on his plate, do not actually exist, for if they do they are of much greater importance than those he specifies.

The wing figured is a very large one, measuring 45 mm. in length, as stated by Geinitz (in his plate it is 46.5 mm. long), and 20.5 mm. broad; this he says is shorter than it should be, the wing being contracted by a transverse wrinkling of the specimen, represented in his plate by some wavy, transverse, narrow bands; the other wing is 50 mm. long and 20 mm. broad, and represents, he thinks, the proper size; it is not impossible, however, that the wings may have actually varied a little in length, and the breadth to the length may be put down as between 1 : 2.2 and 1 : 2.5. Both wings are nearly perfect, the apical edge of each being lost for a little way, and a few of the veins being obscured. The wing we have

chosen for illustration and principal description, as probably delineated with greater accuracy, is a left wing exhibiting the upper surface.

Hind wing. Portions of both hind wings are preserved in connection with the fore wings, but show no outline of their form, but only some branching veins; which from their close resemblance to the scapular and externomedian veins of the front wing, as to the mode and position of their forks, probably belong to these veins; their branching appears to be a little further from the base than in the front wing.

The single specimen known, is, with the possible exception of *Etobl. insignis*, the most perfectly preserved of all palaeozoic cockroaches; for, besides the wings, we have the head, thorax, a part of the body and the legs. It is, therefore, to be hoped that Dr. Geinitz will give a fuller account of it at an early period. The abdomen is probably ill preserved, as it is not represented on the plate, but is said by Geinitz to be 40 mm. long, and about 10 mm. broad, the narrowness of which he remarks. Of the head he makes no special mention; it projects a little beyond the thorax as a transversely oval body, 2 mm. long, and 5 mm. broad. The pronotal shield is longitudinally oval, broadest apparently in front of the middle, its front border well rounded, the sides convex, and the hind border apparently rather straighter than the front, its length 15 mm., and its breadth 10 mm. The two hinder pair of legs are well preserved, apparently shaped much as in modern types; no mention is made of spines; the legs are short, particularly the hind pair, where the whole leg is about 35 mm. long, the femora and tarsi of about equal length, while the tibiae are a little longer; measuring his figure, we have the length of the former, 12 mm.; its breadth, 3 mm.; length of tibia, 14 mm.; its breadth, 2 mm.; length of tarsi, 10.5 mm.; their breadth, 1.25 mm.

The wing is larger than in any other European species, excepting *Anthr. spectabilis*, from which it is readily distinguished by the more arched costal margin, the longer mediastinal area, and the earlier division of the scapular vein. It is related to *Anthr. porrecta* by the extent of the mediastinal area, but the distribution of the branches and the extent of the other areas differ considerably. Geinitz considers it identical with *Etoblatt. didyma* with which he says it closely agrees, specifying, indeed, the illustration of Germar copied in our Pl. 2, fig. 13. He mentions, however, certain differences, such as the greater simplicity and number of the anal veins. But there are much more important differences than these, and such as leave no doubt whatever of the specific, not to say generic, distinction, although there is unquestionably a general resemblance between the two. The shape of the wing is very different from that of *Etobl. didyma*, principally on account of the greater convexity of the costal margin in *Anth. sopita* and the greater median breadth of the wing, as compared with the extremities; in *A. sopita* again the mediastinal area is considerably longer, the scapular area very much narrower, as compared to the breadth of the wing, and its branches longitudinal, instead of oblique, and similar to those of the mediastinal area; the distribution of the veins of the externomedian area is totally different, the branches being mostly simple and inferior in *Anthr. sopita*, while the branches are superior and the uppermost unusually compound in *Etobl. didyma*, and all together cover an extensive area at the apex of the wing, instead of a very narrow one as in *Anthr. sopita*. No differences of importance exist in the internomedian and anal areas.

The single specimen comes from Weissig, Saxony. Lower Dyas.

Anthracoblattina dresdensis. (See figure in text.)

Blattina dresdensis Gein.-Deichm., Sitzungsb. naturw. Gesellsch. Isis, 1879, 12–13, figs.

The fore wing is elliptical and very regularly formed, broadest in the middle; the costal margin is pretty strongly convex, especially on the basal half; the inner margin much straighter, and the tip well rounded. The veins originate a little above the middle of the wing, and curve gently upward before assuming a longitudinal course. The mediastinal vein, beyond the basal fifth of the wing, is nearly straight, scarcely curving upward with a broad sweep apically, and terminating only a little before the apex of the wing; it emits eight or nine rather closely crowded, nearly straight, oblique branches, about half of which are simple, the others simply or doubly forked at or beyond the middle; the area is broadest a little before the middle of the wing, where it is one-third the width of the wing. The scapular vein runs parallel and close to the mediastinal until it forks, a little beyond the end of the basal third of the wing, and then turns downward in a nearly straight course subparallel to the costal margin, to just below the tip of the wing; it emits three equidistant longitudinal branches, the first two of which fork near the origin of the simple third, and embrace between them the upper tip of the wing. The externomedian vein, beyond its curved base, runs in an almost perfectly straight line to just below the extreme tip of the wing, and, commencing to branch just before the middle of the wing, or scarcely beyond the division of the scapular vein, it emits four simple, inequidistant, arcuate branches, which (especially the basal pair) are at first oblique and then longitudinal. The internomedian vein is broadly sinuous in its course, being at first convex in the same sense as the costal margins, afterwards, on parting from the anal furrow, in the opposite sense, and terminates scarcely before the middle of the outer half of the wing; the area then diminishes rapidly in size, and is occupied by only three or four straight, oblique, distant branches, none of which are long, and which become continually shorter apically. The anal area is lost, as well as most of the anal furrow, which apparently terminates not far from the end of the basal third of the wing.

Anthracoblattina dresdensis.

The length of the wing is 28 mm.; its breadth 11 mm., and its breadth to its length as 1 : 2.5. It was therefore somewhat smaller than the average of the genus. The fragment probably represents the upper surface of the left wing, and is nearly perfect, the tip being broken in two places, and the entire anal area absent; the interspaces are filled with a well-preserved reticulation of polyhedral cells. Geinitz compares this species with *Etobl. euglyptica*, and, although he mentions *Anthracobl. porrecta*, fails to see how much more closely it resembles the latter species. Besides the differences he points out in his comparison with the former, the stouter form of the wing and the inferior origin of the externomedian branches should be mentioned. Of the species of Anthracoblattina, it most nearly resembles *A. porrecta*, but differs from it in being less parallel-sided, in the unequal width of the mediastinal area, the frequent forking of the mediastinal branches, and especially in the more simple and regular branching of the scapular and externomedian veins; besides these points, the scapular-externomedian interspace strikes the margin below and not at the apex, and the internomedian branches are more distant. It

is also somewhat closely allied to the much larger *Anthracobl. sopita*, from which it differs principally in the unequal width of the mediastinal area, and the form and infrequent branches of the internomedian area. In the form of the latter area, indeed, it differs from all other species of the genus, the course of the internomedian vein in all the others being broadly and somewhat uniformly arched, while in this it is rather strongly sinuous or sigmoid, and has an unusually small number of branches.

The single specimen known was found in the rubbish at the mouth of the Kaiserschacht, near Klein-Opitz, in Saxony, and, according to Geinitz, is the oldest insect known from the rocks of Saxony. Upper carboniferous.

[The publication of this species was known to me, by the kind communication of Dr. Geinitz, only after the plates were engraved and the printing of the text well advanced. I have, however, been able to place the species in its proper position in the text, to add a wood-cut, and even to alter all references to the genus where necessary.]

Anthracoblattina porrecta. Pl. 4, fig. 5.

Blattina porrecta E. Gein., Neues Jahrb. f. Mineral, 1875, 6, taf. 1, fig. 4; — Ib., Neue Aufschl. Dyas v. Weiss., 6, taf. 1, fig. 4; — Gold., Faun. saraep. foss., ii, 20.

Fore wing. The wing is long and narrow, subequal, the costal border strongly arcuate at the base, but beyond very gently convex to the rather broad, well-rounded tip; the inner margin is broken, but probably nearly straight; the veins originate at about the middle of the base, and curve gently upward before becoming longitudinal. The mediastinal vein follows very closely the costal margin, but at considerable distance, approaching it very gradually in the apical half of the wing, and terminating only just before the apical sixth of the wing; it emits nine or ten oblique, straight, generally simple veins, and occupies about one-third the breadth of the wing. The scapular vein has a regular, gently and and broadly sinuous curve, runs subparallel to the costal margin, and terminates at the tip of the same; it breaks into two shoots just before the middle of the wing, the lower of which emits two apical, superior, simple branches; the upper, at subequidistant intervals, three straight, superior branches, the basal forked, the others simple, similar in direction and appearance to the apical branches of the mediastinal area. The externomedian vein runs closely parallel to the preceding, and emits two inferior branches, one at the point where the scapular vein divides, which is doubly forked, and the other nearly half way to the margin, which is probably singly forked. The internomedian vein is regularly and rather gently arcuate, and terminates on the inner margin a little before the extremity of the mediastinal vein, and emits four long and very gently arcuate, simple branches at regular intervals from the middle of the basal half of the wing. The anal furrow is distinct, very regularly and broadly arcuate, terminating scarcely before the middle of the wing; the anal veins are simple, arcuate, and apparently distant.

The wing is a large one, measuring 34 mm. in length, and 12.5 mm. in breadth, the breath being to the length as 1 : 2.7. The only example known is nearly perfect, and if the upper surface is exposed, represents a left wing, whose inner margin is nowhere well defined, the anal field obscured, and an unimportant fragment of the tip missing. As Geinitz says, it is clearly distinct from any other species, and is peculiar for the reversed similarity of the scapular and externomedian veins, which occupy equal spaces on either

side of the extreme apex. It is much smaller than the preceding species, from which it also differs in form, in the width of the mediastinal area, and the very different distribution of the scapular and externomedian branches. It probably agrees better in size with *Anthr. Rückerti*, from which it is abundantly distinct by the much earlier division of the scapular and externomedian veins. From the succeeding species, *Anthr. winteriana*, it differs strikingly in the greater width of the mediastinal area, and in the distribution of the branches of the externomedian veins.

The single specimen was found in the coal shales of Weissig, near Pillnitz, Saxony. Lower Dyas.

Anthracoblattina winteriana. Pl. 4, fig. 12.

Blattina winteriana Gold., Neues Jahrb. f. Mineral, 1870, 288–89, figs. 1–4; — Ib., Faun. saraep. foss., ii, 19, 25–26, 51, taf. 1, fig. 11.

Fore wing. The basal third or thereabouts of the wing being broken, its shape cannot be fully described, but in the parts which are preserved are some unique peculiarities; the costal margin, straight in the middle of the wing, is afterwards strongly curved, and meets the almost equally curved inner margin at nearly a right angle, the tip being bluntly angulated, an extremely rare occurrence in palaeozoic cockroaches. The mediastinal vein is nearly straight, in near proximity to the costal margin, and when the latter begins to curve toward the apex, this curves in an opposite direction, giving the mediastinal area an elongated lancet-shaped form; the vein terminates at some distance before the apex, probably scarcely before the apical sixth of the wing, and emits a considerable number of rather distant, straight, simple or forked, oblique branches, becoming more longitudinal toward the tip; the area is probably not more than a sixth of the width of the wing, at the middle. The scapular vein is rather widely separated from the mediastinal, and forks probably not far from the middle of the wing, and continues then in a nearly straight line, subparallel to the costal border, and terminates below the tip of the wing, being near the apex double the greatest width of the mediastinal area; it emits, at subequidistant intervals, four straight longitudinal branches, the first compound, the second forked beyond the middle, the others simple, the ultimate branches much more closely crowded than the mediastinal branches. The externomedian vein divides close to the base of the wing, in exactly what manner cannot be said; for in the only specimen known, three very straight veins, which most probably belong to this area, appear at the basal edge of the fragment, the outer ones forking once beyond the middle of the wing, all parallel to the scapular vein, and occupying a small area near the extremity of the inner margin, shorter than that occupied at the margin by the scapular area, and, by the nearly uniform width of the area throughout the wing, forming a striking contrast to the fan-shaped disposition of the scapular branches. The internomedian vein is also parallel to the same veins, showing only a slight tendency to an arcuate course, and terminating at the same distance from the apex as the mediastinal vein; it emits four or more, rather distant, simple or forked, straight and oblique branches.

The length of the fragment is stated by Goldenberg to be about 22 mm., its breadth 13 mm.; the entire length can only be roughly conjectured; it may have been 30 mm. long, or above the medium size; its breadth was to its length probably as 1 : 2.3. Goldenberg's illustration of the natural size would, however, make the fragment only 18.5 mm. long, or his magnified drawing only 21 mm.; the enlargement on our plate chances to

have been based for size upon the smallest of these figures, and is therefore doubtless too small; in length it should have closely resembled *Anthr. Rückerti*. The fragment represents the upper surface of a left wing, in which the basal third, the whole anal field, and part of the internomedian is destroyed. The veins are all deeply impressed, and the interspaces are correspondingly vaulted, but the mediastinal vein, probably by the mode of preservation, is sharply elevated into a ridge. Goldenberg describes the cross venation as nearly effaced, but where traces of it are found, as consisting of a network of delicate quadrangular meshes, visible only by considerable enlargement.

This wing is very peculiar, not only for its pointed apex, but for its elevated mediastinal vein, perhaps due, as remarked, to accident; and also for the nearly equal breadth of its long externomedian area, which is the more striking because unaccompanied by corresponding differences in other parts. These peculiarities forbid any reference of this form to any other species, and render unnecessary any special comparison with allied types. It is placed in its present position, however, because it resembles the preceding species in the distribution of the scapular and mediastinal branches, and the following in the narrowness of the mediastinal area, more than it does the other species; but the resemblance is not very great, nor does it extend to other important parts of the wing. Goldenberg compares it to *Blattina russoma*, but only as regards the size.

The single specimen was found in the Dudweiler coal-pit, near Saarbrücken, Germany. Middle carboniferous.

Anthracoblattina Remigii. Pl. 4, fig. 2.

Blattina Remigii Dohrn, Palaeont., XVI, 133–34, taf. 8, fig. 3; — Gold., Faun. saraep. foss., ii, 20, 26–27, 51, taf. 1, fig. 13.

Fore wing. Nearly the whole of the inner margin is wanting, so that the form of the wing cannot be definitely stated; it would appear, however, to have been nearly equal or slightly tapering, for the principal veins are straight for most of their course, and the costal border is very gently and regularly convex, with the appearance of a fully-rounded apex. The veins originate from above the middle of the wing, and have only a very broad and gentle upward curve near the base. The mediastinal vein runs subparallel to the costal margin, very gradually approaching it, a little more rapidly as the apical third of the wing is entered, terminating scarcely before the apical sixth of the wing; the area is about one-fifth the breadth of the wing, and is filled with a large number (eight to ten) of arcuate, simple branches, longitudinally oblique even at the start, and becoming nearly longitudinal toward the apex. The externomedian vein is much more distant from the mediastinal than from the internomedian vein, has a very gently arcuate, longitudinal course, parallel to the costal margin in the basal two-thirds of the wing, and terminates at the very tip of the wing; it divides, a little before the middle of the wing, into two branches, each of which fork near the tip of the wing only. The externomedian vein runs in close proximity to the preceding, is straight beyond the basal fifth of the wing, is represented by Dohrn as first dividing in the apical third of the wing, and emitting two simple inferior branches; the space, however, in the apical half of the wing between the externomedian and internomedian veins is so great, that there must certainly be at least another, and that probably a forking vein, originating a little beyond the middle of the wing and occupying this space.

The internomedian vein is rather strongly and regularly arcuate throughout, and terminates probably about as far from the tip of the wing as the mediastinal vein; it emits only three similarly arcuate, long, and very distant branches. The anal furrow is not very deeply impressed, rather strongly and regularly arcuate, terminating at a little before the middle of the wing; as the veins originate above the middle of the base, even including the anal furrow, the anal area is very large; the anal veins, to the number of six or seven, are rather distant and simple, at first arcuate, afterwards nearly straight.

The wing is one of the smaller ones, the fragment measuring 14 mm. in length and 6.2 mm. in breadth, the whole wing being probably about 15.5 mm. in length, and the breadth to the length as 1 : 2.5. A large part of the lower outer portion of the wing is broken, but the course of the veins is pretty clear throughout; the upper surface of the wing, which is a left one, is exposed, on which the veins are slightly elevated; but the anal furrow is rather indistinct and depressed, the anal area being vaulted to a considerable degree, while the middle of the wing is rather concave; no cross venation can be seen.

The distant venation of the lower part of the wing, *i. e.*, in the anal and internomedian areas, is in unusual contrast to the crowded distribution of the other branches, and marks this wing as very distinct from others; so, too, the narrowness and equality of the space between the mediastinal and internomedian veins in the basal half of the wing is rather peculiar, and allies the species to the following; from which, however, it is remarkably distinct in the narrowness of the mediastinal area; in this particular, one is reminded only of the preceding species, but the distribution of all the other veins is very different. Dohrn and Goldenberg compare it to *Hermatobl. lebachensis*, with which, indeed, the general resemblance is greater than with perhaps any other palaeozoic cockroach; but besides its lesser size and the comparative narrowness and equality of the mediastinal area, we find the scapular branches superior, instead of being inferior, as in *Hermatobl. lebachensis*.

The single specimen was found in an argillaceous schist in a coal-pit on the Remigiusberge, near Cusel, in Rheinpflalz. Upper carboniferous.

Anthracoblattina Rückerti. Pl. 4, fig. 1.

Blattina Rückerti Gold., Neues Jahrb. f. Mineral., 1869, 163–64, taf. 3, fig. 11.

Fore wing. The apex of the wing only being preserved, and that not perfect, it is impossible to describe the form of the wing; the apical half of the costal border, however, is preserved, showing a curve very similar to that of the species last described. The mediastinal vein, if I have rightly interpreted it, is remarkably distant from the costal margin, so that the area must occupy more than a third of the width of the wing, terminating just before the apical sixth of the wing, and possessing distant, simple, nearly straight, and oblique branches. The scapular vein is straight or scarcely arcuate in an opposite sense to the costal margin, in the outer half of the wing, and terminates scarcely before the tip, dividing only in the apical third of the wing, and emitting at rather wide angles three simple or forked branches. The externomedian runs down the middle line of the wing exactly parallel and close to the preceding, begins to divide at the same point, and has two equally divergent, simply or doubly forked branches, occupying an exactly equivalent area to those of the scapular vein. The internomedian vein is gently arcuate in the distal half

of its course, terminating a little beyond the mediastinal vein, and has a large number of straight, oblique, crowded branches, simple or deeply forked.

The length of the fragment is 16.5 mm.; its breadth, 13.5 mm.; probably the length of the wing was about 30 mm., or a little above the medium size, and the breadth to the length as 1 : 2.2. The restored parts in our plate, however, no doubt represent the wing as too broad, the projecting part of the internomedian area being inaccurately drawn. Goldenberg describes the interspaces as filled with parallel and straight cross lines. If the upper surface is exposed, the wing is a left one.

It is peculiar for the great width of the mediastinal area, even if we have carried it a single vein too far inward; and the regularly opposed and straight distribution of the branches on opposite sides of the scapular-externomedian interspace, which follows nearly the middle line of the wing, gives it a peculiar aspect. Goldenberg compares it to *Hermatobl. lebachensis*, but the different position of the scapular branches, superior instead of inferior, at once distinguishes it from that, not to mention the points referred to by him. It is more nearly allied to *Anthr. Remigii*, from which, however, it may be distinguished at a glance by the far less arcuate form and the much greater frequency of the internomedian branches.

Goldenberg neglects to record this species (of his own description) in his Catalogue of fossil cockroaches (Faun. saraep. foss., ii, 19–21.)

A single specimen, from the Max coal-pit of Stockheim, Oberfranken. Dyas.

Gerablattina nov. gen. (γῆρας, Blattina).

Blattina Auct (pars).

The mediastinal vein of the front wing runs parallel or subparallel to the costal margin, and generally rather distant from it, frequently more distant in the middle of its course than elsewhere, and terminates generally beyond the middle of the apical half of the wing, frequently far toward the very apex; it sends a large, sometimes a very large, number of oblique, straight or curving, usually simple branches to the costal margin. As the division between the scapular and externomedian areas is at or before the tip of the wing (in a single species, *G. Mahri*, perhaps slightly beyond it), the scapular area is necessarily much restricted; generally speaking, it is limited to only a few apical branches, which scarcely originate before the middle of the apical half of the wing; and in one or two, such as *G. Geinitzi* and *G. Münsteri*, there is only a single apical fork; but in *G. Germari* and *G. weissiana* there are several branches, which originate near the middle of the wing: the American species, however, seem to form a distinct section; for notwithstanding that the great length of the mediastinal vein is still retained, the scapular vein begins to branch before the middle of the wing, and emits three or four branches, some of which branch again, and that more than once; the branches of this vein are always superior, whether the extent of the branching be considerable or slight. The externomedian vein is very similar to the scapular, although in some, but not all, of the species in which the scapular area is greatly reduced, it does not suffer to a corresponding extent; in the species placed at the head of the series, as well as in *G. Geinitzi* and *G. Münsteri*, it is considerably more extensive than the scapular area, but in the others, including the American species, it is very similarly developed; all the branches are likewise superior, so that the reverse obliquity of the

branches of neighboring veins appear in this genus in the interspace between the externomedian and internomedian veins. The combined internomedian and anal areas occupy, in the species at the head of the series, somewhat more than half of the width of the wing at the base, about one-half or slightly more than that in the others; and it generally diminishes gradually and regularly in width, and terminates, with rare exceptions, nearer the tip than does the long mediastinal vein; in some species the internomedian vein is nearly straight; in others, however, while there is at first a rapid diminution in the breadth of the area, the vein afterwards runs parallel to the inner border, and extends the area far toward the tip of the wing; the vein has a large number of subparallel, straight or gently curving branches, which are indifferently simple or branched, and the obliquity of which corresponds in most cases very closely, although in a reverse sense, to the branches of the mediastinal vein. The anal furrow is generally pronounced, and straight or gently curved; in one or two, however, it is very arcuate, and, while somewhat irregular in termination, its tip seems never to be far removed from the end of the basal third of the wing; the anal veins, where known, are frequent, parallel, arcuate, and generally simple in the European species and in one of the American species; but in the other American species, *G. fascigera*, they are very different, being nearly straight, multiple-forked, running in a direction somewhat divergent from that of the anal furrow, and approaching the latter only near its termination.

The wings in this genus are slightly above the average in slenderness, being precisely the same, as a whole, as in Etoblattina, the breadth being contained in the length scarcely less than two and three-quarter times.

This genus appears to be most nearly allied to Hermatoblattina, from which it differs sufficiently in the superior position of the branches of the scapular vein; from Etoblattina and Archimylacris it may be separated at once by the great length of the mediastinal area; from Anthracoblattina it differs in having the branches of the externomedian vein superior and not inferior; Progonoblattina, with the wide extent and importance of its scapular and externomedian areas, is readily distinguished from it; Oryctoblattina for similar reasons, as well as for many others, cannot be confounded with it; while the strong backward curve of the externomedian vein in Petroblattina, with the extensive area covered by its longitudinal branches, separates it from that genus at a glance.

Most of the species of the genus, which next to Etoblattina is the richest in known forms, come from the old world; but two American species must be placed here, although the extensive development of the scapular vein would perhaps, as suggested above, warrant separating them as a peculiar section.

Gerablattina Goldenbergi. Pl. 3, fig. 18.

Blattina Goldenbergi Mahr, Neues Jahrb. f. Mineral., 1870, 282–84, fig. 1; — Gold., Faun. saraep. foss., ii, 19.

Fore wing. The apical third of the wing being lost, its precise form cannot be described, but it was evidently long and narrow; the costal margin is regularly and rather strongly arcuate, with a very prominent humeral lobe, the inner margin straight, with its basal angle rather broadly rounded. The veins originate much below the middle of the base and curve strongly upward over a considerable distance, so as soon to occupy the middle of

the upper two-thirds of the wing. The mediastinal area is nearly one-third the width of the wing, the main vein running parallel with the costal margin for a long distance, probably over the basal two-thirds of the wing, beginning to turn toward the border only at the very extremity of the fragment, and probably reaching the border at no great distance before the tip of the wing; it emits nearly a dozen distant, nearly straight, simple and oblique branches. The scapular vein runs closely parallel to the preceding throughout the fragment, supposing the two veins which appear to originate from its under surface to represent the externomedian vein; whether this interpretation is correct, neither the description nor the illustration of Mahr enable us to state positively; but the resemblance of this wing to others of the genus in which we place it renders it probable that here, as is usually the case in the genus, the scapular is of less importance than the externomedian vein, and in such a case only one of the three veins which lie between the mediastinal and internomedian veins in the middle of the wing can belong to the scapular vein; although this vein is simple in the fragment, the turn of the mediastinal vein toward the costal border renders it nearly certain that it forks at least once or twice in the apical third of the wing. The externomedian vein, on the same assumption, divides into two branches before the middle of the wing, each of which again forks beyond the middle of the wing, and undoubtedly branches again beyond that, probably occupying upon the margin all the space from a little above the tip to the extremity of the internomedian area; the general course of the vein is at first strongly arcuate, afterwards longitudinal. The internomedian vein is strongly arched in the basal half of the wing, then becomes straight or bent a little toward a longitudinal direction, and probably terminates about as far from the tip as the mediastinal vein; it emits only three branches, the first forked, the others simple, all gently arcuate, oblique, and distant; the veins of this area are represented by exceedingly heavy lines in Mahr's illustration, but as he makes no mention of any difference between them and the others, this is probably an error. The anal furrow is very strongly arcuate indeed and deeply impressed, terminating, probably, a little before the middle of the wing; the anal veins, according to Mahr, are ten in number, but many more are represented in his figure, which is carefully followed in our plate; these are all arcuate, regular, simple, and, in striking contrast to the other areas, closely crowded.

The wing is of medium size, the length of the wing being 15.5 mm., while the entire length of the wing is probably about 23 mm.; its breadth is 9 mm., and the breadth to the length as 1 : 2.55. From Mahr's statement that the anal field is concave, the under surface is evidently exposed to view, and the wing is therefore a right one.

It is remarkable for the great extent of its anal area, by which it is readily separated from all the species of the genus in which this area is known, and for the close proximity of the veins in this area as contrasted with their wider separation in the rest of the wing; in the uniform belt-like nature of the mediastinal area it resembles several of the species, particularly *G. clathrata*, *G. intermedia*, and *G. Mahri*; from the first of these it is quickly distinguished by the distance of the branches of the mediastinal vein, in which particular it more nearly resembles the other species; from *G. Mahri* it differs greatly in size and in the convexity of the costal margin; and from *G. intermedia* in the early division of the externomedian vein and the strongly-curved internomedian vein.

A single specimen, from an argillaceous schist between the third and fourth veins of the Ilmenau coal basin, Manebach. Upper carboniferous.

Gerablattina clathrata. Pl. 3, fig. 4.

Blattina clathrata Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 288, 294–96, pl., figs. 3, 3ª, 3ᵇ; — Gold., Faun. saraep. foss., ii, 19.

Fore wing. The extreme tip and most of the anal area are wanting, and the inner margin is also broken, so that the precise form is uncertain; it is, however, tolerably broad, and the costal border rather strongly and regularly arcuate, much as in the preceding species, but with a very slight humeral lobe; the principal veins are all almost similarly arcuate, originating near the middle line of the wing, and running subparallel to the costal margin; the branches on either side being very frequent, long, and straight, and, parting from their stems at an equal angle, give the wing a peculiarly simple appearance. The mediastinal vein runs nearly parallel to the costal margin, but is more distant from it in the middle than at the base of the wing, is bent at the origin of its first branch, the humeral lobe being devoid of branches, begins to approach the margin a little beyond the middle of the wing and terminates at the very end of the fragment, or probably about midway between the middle of the costal border and the extreme tip of the wing; it emits about a dozen closely-crowded, straight or nearly straight, simple or occasionally apically-forked, oblique and nearly parallel branches, the direction of the apical not diverging greatly from that of the basal branch; the area is very broad, occupying nearly one-third the breadth of the wing. The scapular vein, appearing to originate from the same stem as the externomedian and to separate from it in the middle of the basal half of the wing, runs close and parallel to the mediastinal, until that vein turns toward the costal margin; it retains thereafter its former direction for some distance, and then turns very slightly and gradually upward, and terminates just before the tip; in this apical portion it emits three closely approximated branches, the first next the last branch of the mediastinal vein, and basally forked, the others simple and soon parallel to the main stem. The externomedian vein does not fork until past the middle of the wing, and, just this portion being destroyed, it is impossible to give a precise statement, but in any case the distribution of the veins is peculiar, for the three or four straight and simple branches, which occupy the tip of the wing and run subparallel to the scapular branches, spring, in the apical fourth of the wing, from a vein which runs almost exactly parallel with the costal border, and in continuation of the main externomedian vein; while the other three or four branches, which strike the apical part of the inner margin, run parallel to the internomedian branches, and are much longer than the other externomedian branches, running parallel to each other in a straight and simple course, and originating, in some indeterminable manner, scarcely beyond the middle of the wing. The internomedian vein is rather strongly and very regularly arcuate, terminates a little nearer the apex than the mediastinal area, and emits about ten nearly straight, very long, parallel, oblique veins, the first doubly forked, the others simple; the area at its broadest occupies considerably more than half the breadth of the wing. The anal furrow is well impressed, strongly arcuate, apically nearly straight, terminating not much beyond the basal third of the wing; one or two fragments of anal veins next to the furrow are preserved, running parallel to the same.

The wing is of rather large size, one of the largest of the genus, the fragment measuring 32 mm. in length, and 13.5 mm. in breadth; the whole wing is probably 35 mm. long, according to Heer, the breadth being to the length as 1 : 2.6. By some accident it has

been represented upon my plate as magnified slightly less than twice. From Heer's description of the reticulation, probably the upper surface is exposed, and the wing is that of the left side; all the interspaces, according to Heer, are filled with a very fine network, as in *Oryctobl. reticulata*, consisting of polygonal cells, forming from two to four rows in each interspace, whence the specific name.

The species is peculiar for the regular distribution of the branches, parting in a uniform manner on either side of the principal veins; and for the unusual distinction of the upper and lower branches of the externomedian vein, which take the direction, — the upper of the scapular, the lower of the internomedian branches. In the great breadth, length, and uniformity of the mediastinal area, this insect resembles several of the species of Gerablattina, but especially *G. Goldenbergi* and *G. Mahri*. In the form of the wing it most resembles the former species, from which it is readily distinguished by its larger size, the much greater extent of its internomedian and much smaller extent of its anal area. From *Gerabl. intermedia*, with which it agrees to a certain extent in the apical division of the scapular and externomedian branches, it is readily separated by the far more crowded neuration and the larger size of the wing.

The single specimen comes from the coal-measures of Manebach, in Thüringen, associated with leaves of *Pecopteris arborescens*. Upper carboniferous.

Gerablattina intermedia. Pl. 3, fig. 11.

Blattina intermedia Gold., Faun. saraep. foss., ii, 19, 24–25, 51, taf. 1, figs. 10, 10ª.

Fore wing. The wing is of an obovate form, its regularity only lost by the prominence of the anal angle and the relatively diminished size of the humeral lobe; the costal border is considerably arcuate, but the humeral lobe so little developed as to be less full than the inner angle; the inner margin is gently arcuate, and the tip broad and broadly rounded; the veins originate from about the middle, perhaps above the middle, of the base, and are gently arcuate at their origin. The mediastinal vein, subparallel to and rather distant from the costal margin, turns rather rapidly toward it somewhat beyond the middle of the wing, and terminates in the middle of the outer half of the wing, emitting seven distant, arcuate, oblique, parallel, simple branches; the area occupies a little less than one-third the breadth of the wing. The scapular vein runs parallel to the costal margin until it branches in the middle of the third quarter of the wing, beyond which it curves toward the margin, and half way to it emits a second and only other branch, which is simple, the first being forked. The externomedian vein, which appears to be coalesced with the preceding in the basal fourth of the wing, runs parallel to the internomedian, and does not fork until it has reached the apical fourth, when it only emits from its upper surface two simple, short, and straight branches, which, with the main vein, occupy the tip of the wing, and leave a wide space between the scapular and externomedian veins. The internomedian vein is rather gently arcuate at the base, and beyond nearly straight, inclined downward, terminating a little before the tip of the wing, and emitting half a dozen or more distant, straight or gently arcuate, simple or apically forked, oblique branches.

The wing is of medium size, measuring 22 mm. in length and 10 mm. in breadth, the breadth to the length being as 1 : 2.2. If the upper surface is exposed, it belongs to the right side. The anal area is lost, but otherwise the wing is perfect, and in certain places,

says Goldenberg, one may see with a lens a delicate polygonal reticulation in the interspaces, which he represents as formed of very closely approximated cross lines, often connected near the middle by oblique cross lines, so as to form elongated interdigitating cells.

This wing is peculiar, as Goldenberg remarks, for the very slight development of the scapular and externomedian veins, and especially for the apical division of the latter. He might also have added, its open neuration. In comparing it with "*Blattina flabellata* Germ.," Goldenberg doubtless had in mind our *Gerabl. Münsteri*, with which it no doubt agrees in general features, but is at once distinguished by the peculiar marks of the species just referred to; it is, however, more closely related to the species described by Goldenberg at the same time, *Gerabl. scaberata*, which also has very sparse neuration. It differs from this, however, in the character of the mediastinal branches, which are far more longitudinal in *Gerabl. scaberata*, and some of them also forked, while the division of the scapular and externomedian veins in that species is even simpler than here. In the apical division of these two veins just mentioned it is related to *Gerabl. clathrata*, but the smaller size and openness of the neuration at once separate it from that species.

The single specimen comes from a bluish bituminous shale at Wemmetsweiler, near Saarbrücken, Germany. Middle carboniferous.

Gerablattina scaberata. Pl. 3, fig. 3.

Blattina scaberata Gold., Faun. saraep. foss., ii, 19, 25, 51, taf. 1, fig. 8.

Fore wing. The fragment preserved is exceedingly imperfect, and all that can be said of the form of the wing is that its costal border, away from the two extremities, is nearly straight or scarcely arcuate. The neuration of the wing, however, is sufficiently preserved to indicate its probable place in this genus, and to distinguish it from the other species of the same. The mediastinaal vein runs parallel to the border in the basal third of the wing, then approaches it very gradually, terminating in the middle of the apical half; it is very distant from the margin, the area probably occupying about one-third the width of the wing; it emits half a dozen straight and very long, longitudinally oblique veins, some of the basal ones rather deeply forked, the others simple, and all distant. The scapular vein terminates just before the tip, is nearly straight from beginning to end, and probably emits only a single, and that a simple, branch at the middle of the outer half of the wing; for there is hardly space for more. The externomedian vein runs in a straight course down the middle of the wing, and can hardly fork more than once,[1] and that beyond the middle. For the internomedian vein also runs in a straight line along more than half the wing, and must terminate scarcely below the tip; only one branch of this vein can be seen, and this has an unusually longitudinal trend, like the branches of the mediastinal vein.

The wing is of tolerably large size, the length of the fragment being 25 mm.; its breadth, 7.5 mm.; the probable length of the wing is 30 mm., but its breadth can only be conjectured. The base, almost the whole of the lower half of the wing, and a large part of the tip are lost. If the upper surface is exposed, the wing is of the right side. Goldenberg mentions that no reticulation can be discovered, but that the interspaces are sprinkled with small raised points.

[1] In the plate the branch of this vein should have been given in dotted lines at the base as well as beyond.

The wing is peculiar for the longitudinal direction of the branches of the mediastinal and internomedian veins, and also for the simplicity of the scapular and externomedian branching; the latter, indeed, is only inferred, but reasonably so, from the openness of the existing neuration, the small space left for branches, and the extreme straightness of the principal veins, which is another peculiar feature of the species. It is more nearly related to the preceding species than to any other, but is readily distinguished from it by all the features above named, and by the straightness of the costal margin.

The single specimen was found in a bluish bituminous shale from the culm of the Altenwald mine, near Saarbrücken, Germany. Middle carboniferous.

Gerablattina Geinitzi. Pl. 2, fig. 11.

Blattina Geinitzi G d., Neues Jahrb. f. Mineral., 1869, 160–61, taf. 3, fig. 5; — Ib., Faun. saraep. foss., ii, 19.

Fore wing. The wing is of peculiar form, the costal margin being straight nearly to the tip, while the inner border is rather strongly arcuate and the tip well rounded; Goldenberg considers the humeral angle as complete, and therefore states, as another point in contrast to the form of the wing in other ancient cockroaches, that it does not project so far basally as the anal angle; but this would hardly seem consistent (to the extent figured) with the use of the wing, and we are therefore forced to believe the wing imperfect. The veins originate from the middle of the upper half of the base, and do not curve upward. The mediastinal vein, owing to the straightness and basal contraction of the costal margin, is nearer the margin basally than beyond, pursuing an arcuate course, first divergent from, afterwards convergent with the margin, and terminating only a little before the apex, or at the extremity of the straight portion of the margin; the area is widest in the middle of the wing, where it is less than a fourth of the entire width of the wing, and is filled with frequent, longitudinally oblique, simple, arcuate veins, about eight in number. The scapular vein is remarkable for its excessive simplicity, following close to the mediastinal vein, and forking once only and close to the extremity, beyond the origin of the last mediastinal branch. The externomedian, on the contrary, has a broadly sinuous course through nearly the middle of the wing, and although it begins to fork before the end of the basal third, it only occupies, with its three branches, the extreme apical border of the wing; the branches are equidistant, the last emitted before the end of the middle third of the wing, superior, longitudinal, and closely crowded apically, the first one (in the only specimen known) simple, the next simply, the last doubly forked. The internomedian vein is subarcuate, or bent in a sense opposite to what is usual in palaeozoic cockroaches, the basal half being nearly straight and bent downward, the apical nearly straight and sublongitudinal, terminating just before the tip, where the scapular vein ends, and emitting about eight crowded, subarcuate, simple or forked veins, the apical much more longitudinal than the basal. The anal furrow appears to be lightly impressed, gently arcuate, terminating a little before the middle of the wing; the five anal veins are at first simple and arcuate, like the furrow, afterwards forked and straighter.

The wing is of small size, measuring 14 mm. in length and 4.75 mm. in breadth; or the breadth to the length nearly as 1 : 3. If the upper surface is exposed, the wing is from the right side. Goldenberg makes no mention of the surface characters. The wing is

unusually perfect, but probably the basal portion at the humeral lobe is wanting. It is peculiar for the straightness of its costal margin as contrasted with the fullness of the inner margin, for the basal narrowing of the mediastinal field, and for the extreme apical simple forking of the scapular vein. In the first and last of these features it is undoubtedly allied to the preceding species, but is readily distinguished from that by its narrower mediastinal field, as well as by abundant division of the externomedian vein, the smaller size of the wing, and the much more crowded neuration. *Gerabl. Münsteri* has a somewhat similar scapular vein, and also has a crowded neuration, but it also has an extremely wide mediastinal field, in striking contrast to this species; its straight costal margin also at once separates this species from *Gerabl. Münsteri*, as indeed from all the other unmentioned species of this genus.

The single specimen found comes from Löbejün, Germany. Upper carboniferous.

Gerablattina Münsteri. Pl. 2, fig. 12.

Blattina flabellata Germ., Verst. Steink. Wettin, 84–85, tab. 31, fig. 5ª, 5ᵇ; — Gieb., Ins. Vorw., 315. Not *Bl. flabellata* Germ., Münst. Beitr. (for which see *Etobl. flabellata*).

Fore wing. The costal margin is rather strongly and regularly arcuate, while the inner margin is straight; and the wing, being broadest at the end of the basal third, tapers very regularly thereafter to the tip, which is broken, but probably well-rounded; the veins originate a little above the middle of the base, and curve a little upward at first. The mediastinal vein is arcuate at base, straight and subparallel with the costal margin beyond and past the middle of the wing, curving gently toward the margin, which it does not reach until about the middle of the apical fourth of the wing; the area is very broad, being fully two-fifths the entire breadth of the wing in the middle of the latter, and emits a large number, a dozen or more, of nearly straight, mostly simple, occasionally forked, branches, the basal ones transversely oblique, the apical longitudinally oblique. The scapular vein is very simple, broadly sinuate, follows the course of the mediastinal vein, and, passing nearly through the centre of the wing, forks once in the middle of the apical half of the wing, and occupies only an extremely narrow area on the extreme apical portion of the costal margin. The externomedian vein appears to be coalesced with the scapular in the basal fourth of the wing, but both before and after its separation follows exactly parallel and close to the internomedian vein, which terminates probably almost as near the apex as the scapular vein, leaving for the externomedian vein only the very apex of the wing; it begins to branch a little before the middle of the wing, and emits, at equidistant intervals, three longitudinal branches, the middle one arising in the middle of the wing, and simple, the others simply or doubly forked, so that the apex is crowded with veins. The internomedian vein is rather strongly arcuate at base, then runs downward in a nearly straight line toward the middle of the apical half of the inner margin, until nearly the end of the middle third of the wing, when it turns suddenly outward, and runs parallel to the inner border, doubtless afterwards approaching it, and probably terminating only when the apical margin is reached; it emits about eight straight, oblique veins, the short apical ones only slightly more longitudinal, all simple excepting one which is compound, and fills the apical part of the regular portion of the area. The anal furrow is distinctly impressed, rather gently and regularly arcuate, and

terminates a little beyond the basal third of the wing; the anal veins, six in number, are simple and similarly arcuate.

The wing is somewhat below the medium size, the fragment being 17.25 mm. long and 6.5 mm. broad; probably the real length of the wing is 18.5 mm., and the breadth to the length as 1 : 2.85. The upper surface of the wing appears to be exposed, and is that of the left side. Germar speaks of the principal mediastinal and internomedian veins as delicate.

Germar confounded this species with that formerly described by him in Münster's Beiträge under the name of *Bl. flabellata*. It is indeed very close in general appearance, but if the figure given in Münster's Beiträge is correct, two species belonging to different genera are indicated. The principal difference is to be found in the upper half of the wing. In *Etobl. flabellata* (as first described, and as we have restricted it), the mediastinal area is very narrow, and the vein terminates at about the middle of the costal margin; in *Gerabl. Münsteri*, on the other hand, the area is very broad, and the vein terminates only just before the apex. In *Etobl. flabellata* again the scapular area is extensive, and filled with many veins; in *Gerabl. Münsteri*, the scapular vein is simply forked once. Or, to put it otherwise, the branches of the basal half of the mediastinal vein of *Gerabl. Münsteri* are transferred, in *Etobl. flabellata*, to another short principal vein, running above the mediastinal, and which does not exist in *Gerabl. Münsteri*; while the scapular vein of the latter, amalgamated at base with the three-branched externomedian vein, is to be considered, in *Etobl. flabellata*, as the basal branch of a four-branched externomedian vein. The close resemblance of the externomedian and internomedian areas in the two wings would have led me to consider the illustration in Münster's Beiträge as simply faulty, were it not for the following considerations: First, Germar makes no mention of any such error, but merely quotes the reference in his synonymy. Second, there are several points of difference besides those pointed out; for instance, the shape of the wing, which is less tapering in *Etobl. flabellata*, with a less arcuate costal, and a more arcuate inner margin; the compound branch of the internomedian vein, found just beyond the middle of the wing in *Gerabl. Münsteri*, is represented in *Etobl. flabellata* by a pair of forked branches, having a widely distinct origin; the simply forked vein which I have considered the scapular in *Gerabl. Münsteri* originates from the externomedian vein much nearer the base than in *Etobl. flabellata*; and the borders of the broken tip do not agree in the two wings. Third, if they are to be considered the same, the correct drawing is certainly the later one, but the structure of the mediastinal vein is circumstantially described, as well as figured, in both of Germar's works, in each case corresponding to the illustration in the same work; yet the structure of the wing of *Etobl. flabellata* is wholly in keeping with that of the genus Etoblattina, which comprises the largest proportion of the European palaeozoic cockroaches, and is indeed very closely related indeed to that of *Etobl. affinis* and *Etobl. anthracophila*, as we have already pointed out; and were it not for the remarkable similarity of the distribution of the nervures referred in *Etobl. flabellata* to the externomedian vein, it scarcely seems probable that any doubt would arise concerning the distinction of the two species. Unless Germar's original types exist, and can be verified, it seems questionable whether the point can really be decided.

Germar, in his Wettin fossils, compares this species to *Etoblattina anaglyptica*, which he says it closely resembles, so that one might take it for a small specimen of the same, but as we have seen above, the Wettin species must be placed in Gerablattina and not in Etoblat-

tina. It is related to *Gerabl. Geinitzi* by the simple structure of the mediastinal vein, and the branching of the internomedian, but is at once distinguishable from it by the extreme breadth of the mediastinal area, and by the general shape of the wing. In the distribution of the externomedian veins it also resembles *Gerabl. producta*, but it hardly resembles it in any other feature, unless it be the shape of the wing. The structure of this same vein separates it from all the other species of the genus. Giebel plainly describes the Wettin species, and mistaking the scapular vein for the first branch of the externomedian (since they are united at the base) considers the internomedian as entirely wanting, and suggests that it should therefore form a peculiar genus.

The single specimen comes from Wettin, Germany. Upper carboniferous.

Gerablattina producta. Pl. 3, fig. 2.

Blattina euglyptica pars Gold., Neues Jahrb. f. Mineral., 1869, 162–63, taf. 3, fig. 9 (nec. 8).

Not *Bl. euglyptica* Germ. (for which see *Etobl. euglyptica*).

Compare also synonymy of *Etobl. Dohrni*.

Fore wing. The wing is rather broad and subovate, the costal margin strongly and regularly arcuate, contracted at the humeral lobe, the tip well rounded and the inner border nearly straight. The veins originate considerably above the middle of the wing, and are scarcely turned upward at the base. The mediastinal vein, however, curves upward nearly as much as usual next the base, where it is unusually near the costal margin; but beyond the base it is straight, and follows nearly parallel to the costal margin until past the middle of the wing, when it bends very slightly toward the margin, and terminates in the middle of the outer half of the wing; it emits about eight straight, oblique, mostly simple veins, and the area at its widest is scarcely one-quarter the width of the wing. The scapular vein is nearly straight from one end of the wing to the other, and terminates just above the extreme apex, separating an upper third of the wing from a lower two-thirds; commencing to divide at the middle of the wing, it emits four straight, obliquely longitudinal, superior branches, the first forked beyond its middle, the others simple. The externomedian vein is also nearly straight, but diverges a little from the preceding beyond the basal third of the wing, and terminates below the tip of the wing, and a little farther from it than the scapular vein; it commences to branch a little beyond the basal third, and emits about four straight, longitudinal, forked or simple branches at subequal distances all the way to the end. The internomedian vein is somewhat peculiar; straight, or perhaps a little arcuate at the base, it bends downward toward the lower outer angle of the wing in the second fourth of the same, and then takes a longitudinal course nearly parallel to the inner border, which it retains to the end, being throughout this portion of the wing slightly broader than the mediastinal area, or a little more than half the width of the combined internomedian and anal areas near the base; on account of the length of the apical portion of this area, I have proposed the above specific name; the vein emits about eight simple, oblique, straight, arcuate or sinuous, rather distant branches, the apical ones much more longitudinal than the basal. The anal furrow seems to be lightly impressed, rather gently and uniformly arcuate, and terminates at about the end of the middle third of the wing; the three or more anal veins are similarly arcuate, simple, and unusually distant.

The wing is of medium size, being 26.5 mm. long and 11.25 mm. broad, the breadth to the length being as 1 : 2.35. The wing is a right wing, viewed from above, exhibiting no cross venation.

Goldenberg described this insect as identical with *Etobl. Dohrnii*, and referred both to *Etobl. euglyptica*. This species, however, differs from both of them in the greater length of the mediastinal area, the later branching of the scapular vein, and the earlier branching of the externomedian vein. From *Etobl. euglyptica*, and to a lesser degree from *Etobl. Dohrnii*, it differs in the unusual form of the internomedian area, one of the characteristic marks of this species; while the wing is also much broader in proportion to its length than in those species, and differs considerably in form from *Etobl. euglyptica*. The differences between the other two species are stated in the proper place. The larger size, narrower mediastinal area, and ovate rather than tapering form, as well as the more complicated scapular vein, distinguish this species from *Gerabl. Münsteri*, to which it appears to be most nearly allied. In the narrowing of its mediastinal area at either extremity, in the character of the externomedian branches, and to a certain extent in the form of the internomedian area, it is to be compared also with *Gerabl. Geinitzi*; but it differs very much in the form of the wing as well as in the character of the scapular vein. From the species which follow it differs to such an extent in the extended production of the internomedian area, as by no means to be confounded with them.

The single specimen comes from Wettin, Germany. Upper carboniferous.

Gerablattina Germari. Pl. 3, fig. 6.

Blattina sp. Germ., Verst. Steink. Wettin, vii, 87, tab. 31, fig. 9.
Blatta Germari Gieb., Ins. Vorw., 321.
Blattina Germari Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 288; — Gold., Faun. saraep. foss., ii, 19.

Fore wing. The wing is slender and tapers considerably, besides being slightly curved; the costal margin is very strongly and regularly convex, the inner margin straight or very slightly concave and a little convergent with the costal border, narrowing the rounded tip unusually; the veins apparently originate near the middle line of the wing, and curve upward a little at the base. Beyond the base the mediastinal vein runs longitudinally in a straight line to the middle of the wing, at a great distance from the costal margin, which it reaches at about the middle of the outer half of the margin; this area at its broadest occupies more than two-fifths the breadth of the wing. The scapular and externomedian veins appear to run together, and in very close proximity to the mediastinal vein, as far as the middle of the wing, and then divide, the scapular running to the apex of the wing and dividing, so that about half a dozen veins strike the costal margin. The externomedian vein, having but a narrow space to expand in, appears to emit only a single forked branch or two from near the middle of its free course, furnishing about five veins to the extremity of the inner margin. The internomedian vein, also running so close to the mediastinal in the basal half of the wing as to occupy the middle line of the wing, and crowding the middle pair of principal veins together, turns toward the inner margin more slowly than does the mediastinal toward the costal border, and, having throughout a broadly arcuate course, strikes the inner margin a little before the apical sixth of the wing; it emits four straight, oblique,

simple or apically forked branches. The anal furrow is well impressed, strongly and regularly arcuate, and terminates near the middle of the wing; the anal veins that can be seen are simple, closely approximate, and similarly arcuate.

This is one of the smallest species, measuring only 11.5 mm. in length by 3.75 mm. in breadth, the breadth being to the length rather more than 1 : 3. If the upper surface is exposed, it is a left wing. Germar does not describe it, believing the neuration too imperfect for determination; but it is sufficiently preserved, to judge from his illustration (on which this description is based), to determine its generic and specific relations with a reasonable certitude. The form, excepting perhaps at the base, is well preserved, and this separates it at once from all known species. In size it agrees only with *Etobl. parvula* and *Etobl. insignis*, from which it is at once separated by the extent of the mediastinal area. The mediastinal branches are obliterated, as well as the base of those of the scapular and externomedian areas, but the extent of the mediastinal area, and the common distance from the base at which the scapular and externomedian veins divide, show that it belongs to this genus; while by the close approximation of all the principal veins in the basal half of the wing, as well as by its size and form, it is readily distinguishable from all the other species of the genus. It has no very close affinities to any of the species, although perhaps nearest to *Gerabl. Mahri*, beside which we have placed it.

One specimen, Wettin, Germany. Upper carboniferous.

Gerablattina Mahri. Pl. 3, fig. 14.

Blattina Mahri, Gold., in Mahr., Neues. Jahrb. f. Mineral, 1870, 284–85, fig. 2^a, 2^b; —Gold. Faun. saraep. foss., ii, 19.

Compare also synonomy of *Blattina elongata*.

Fore wing very slender and somewhat tapering, the costal margin rather gently arcuate on the basal third, beyond nearly straight, the inner margin, at least in the middle, straight. The veins originate below the middle of the wing, and are strongly arcuate at the base. The mediastinal vein follows closely the curve of the costal margin, showing no tendency to approach it throughout the fragment, that is, probably, as far as the middle of the apical half of the wing; it probably terminates only just above the tip, and emits about ten straight, oblique, equal, very distant, simple branches; the area occupies nearly or quite a third of the breadth of the wing in its apical half. The scapular vein is closely parallel to the mediastinal, but very distant from it, running scarcely above the middle line of the wing; it forks once in the middle of the wing, and, to judge of the openness of the neuration, probably not again, the two forks probably enclosing the extreme tip of the wing between them. The externomedian vein is distant from the scapular vein, but not so distant as the former is from the mediastinal; beyond the base, which is lost, it is straight and longitudinal nearly to the middle of the wing; just before this it is bent rather abruptly and slightly downward, and runs nearly parallel to the internomedian vein, emitting near together, just beyond the middle of the wing, two superior, longitudinal, simple, straight branches. The internomedian vein is very gently and uniformly arcuate, and being also as distant from the externomedian as the latter from the scapular vein, the area is unusually narrow and slender, the vein probably terminating a little before the middle of the apical half of the wing; it emits half a dozen nearly straight, oblique, mostly simple, parallel, and distant

branches, the second only apically forked in the specimen, and, so far as preserved, the only forked vein in the wing; the anal furrow is slight, rather gently arcuate, apically straight, terminating at the end of the basal third of the wing.

The wing is a very large one, the fragment measuring 40 mm. in length, and 15 mm. in breadth; the whole wing is probably 47 mm. long, so that the breadth is to the length as 1 : 3.1. Goldenberg estimates the length at 45 mm. The base is broken obliquely, so that the anal veins are absent, and a considerable portion of the apex is wanting, particularly next the inner margin. If the upper surface is exposed, the wing is of the left side; the veins are very prominent, and the interspaces are filled with a close, irregular net work of delicate cross veins, particularly distinct in the interspaces on either side of the first internomedian branch.

This species is peculiar, both for the sparseness of the neuration, and for its extreme simplicity, only one of the many branches preserved being forked; it is also much more elongated than most of the species, and has an excessively long mediastinal area, reaching nearly to the tip of the wing, and, notwithstanding the slenderness of the scapular area, throwing the externomedian branches wholly upon the inner side of the apex. In the slenderness of the wing the preceding very much smaller species approaches it, and in simplicity *Gerabl. weissiana* seems nearly allied, but it is readily distinguishable from both by the extreme length of the mediastinal area.

The single specimen was obtained in the "upper division of the Thuringen carboniferous series," at Manebach, in the neighborhood of Ilmenau. Upper carboniferous.

Gerablattina weissiana. Pl. 3, fig. 1.

Blattina euglyptica var. *weissiana* Gold., Neues Jahrb. f. Mineral., 1869, 163, taf. 3, fig. 10; — Ib., Faun. saraep. foss., ii, 19.
Blattina weissiana Gold., Faun. saraep. foss., ii, 26, 51.

Fore wing. Only a part of the upper half of the wing being preserved, its form cannot be stated, but the costal margin is strongly and regularly arcuate, and the tip apparently well rounded; the veins are arcuate at the base. The mediastinal vein runs entirely parallel to and not very distant from the margin until beyond the middle of the wing, when it gradually approaches it, and terminates in the middle of the outer half of the wing; it emits nine or more straight, parallel, rather longitudinally oblique, simple branches. The scapular vein also runs parallel to the costal margin, and terminates just before the extreme tip; it begins to divide at a little distance beyond the middle of the wing, and in quick succession emits three nearly longitudinal branches, whose course cannot be traced far beyond their origin. The externomedian vein diverges slightly from the preceding in the basal half of the wing, running in a nearly longitudinal course about as far from the mediastinal vein as the latter is from the margin; it probably terminates not much further below the tip than the scapular above it,[1] and only the extreme apex is therefore occupied by this vein and its two branches; these branches are longitudinal, and arise near together, one at, the other a little beyond, the middle of the wing, and seem to crowd this part of the wing with veins more closely than elsewhere. The internomedian is represented by

[1] Wrongly represented on our plate by the outside mark, as if the internomedian vein belonged to this area.

Goldenberg as straight, and no inferior branches are preserved; a simple superior branch, running parallel to the main stem, is represented as arising at the end of the middle third of the wing.[1]

The wing is a large one, the length of the fragment being 33 mm.; its breadth, 10 mm.; the probable length of the wing, 35 mm.; its breadth, perhaps 12.5 mm.; making the breadth to the length as 1 : 2.8. Goldenberg gives the probable breadth as 15 mm., and the breadth to the length as 1 : 2.4, and this breadth is represented by the dotted lines on our plate, where Goldenberg is followed. The straightness, however, and the slight obliquity of the internomedian vein, render it probable that the internomedian area was a narrow one, more as appears in *Gerabl. balteata*, for instance, and the longitudinal direction of all the veins and all the branches render it all the more probable; for longitudinal branches in the internomedian area are generally correlated with a narrow area; there is no reticulation in the interspaces, and the wing, if the upper surface is exposed, is of the left side.

The extreme base, the whole of the anal area, all of the internomedian area below the main vein, the neuration of the apical third of the wing, and the lower half of the margin of the entire wing are destroyed; enough, however, remains to indicate both the generic and specific alliances of the insect, and to show that it is certainly distinct from any other described form. Goldenberg's first reference of the insect as a form of *Etobl. euglyptica* was natural, from the general resemblance of the neuration to what is found in that insect; but the much greater length of the mediastinal area, not to mention the more apical division of the scapular vein, at once forbids such a reference. In the form of the wing and in the general distribution of the veins it most nearly resembles, perhaps, the American *Gerabl. balteata*, but the far more apical division of the scapular and externomedian veins, and especially of the former, separates it at once. In these points it is more closely allied to *Gerabl. Mahri*, but the wing cannot be so slender as there, nor so large, and the mediastinal area is much shorter.

Goldenberg considers this species allied to *Etobl. euglyptica* and *Bl. latinervis* on account of the uncommon breadth of the veins, and to the liassic *Legnophora Girardi* on account of the smoothness of the margin, which the veins do not quite reach.

The single specimen comes from Brücken, Canton Waldmohr, in the Rheinpflatz. Upper carboniferous.

Gerablattina balteata, nov. sp. Pl. 6, figs. 9, 10.

Blattina sp. Font.-White, Upp. carb. flora W. Va., pl. 22, fig. 16, 16[a] [ined.].

Fore wing. The form of the wing cannot be definitely stated, as a large part of both base and apex are wanting; the costal margin, however, is moderately and regularly convex, and the inner margin nearly straight, and parallel to the former, indicating a moderately slender wing of a somewhat ovate shape, tapering at either end, and largest near the middle. The veins are arcuate at the base, and probably originate near the middle of the wing. The mediastinal vein runs subparallel to the costal margin, but is straight to just beyond the middle of the wing, when it curves gradually toward the costal margin, and

[1] Two are incorrectly represented on our plate, following Goldenberg's first representation of the same.

terminates near the end of the middle third of the wing; in the fragment, which represents all but the basal fourth, there are about eight feeble, simple, gently arcuate, rather distinct, longitudinally oblique branches, and the middle breadth of the area is scarcely less than one-fourth the width of the wing. The scapular vein, in the basal third or fourth of the wing, runs in very close proximity to the mediastinal vein, then diverges from it, being directed toward the apex of the wing; but a little past the middle it returns by a broad curve to its former trend, and terminates probably just before the extreme tip of the wing; in the fragment it emits four branches, and in the apex, which is destroyed, it probably had one or two more; the first of these four is thrown off where the vein diverges from the mediastinal, viz., a little beyond the basal third of the wing; and this branch continues subparallel to the mediastinal vein, but is compound, forking once next the second forking of the scapular vein, each fork again dividing at unequal distances before reaching the border; the other branches are simple, and originate at unequal distances apart, the second in the middle of the wing. The externomedian vein follows very nearly the same sinuous course as the scapular, but constantly a little divergent from it, and widely distant from both it and the internomedian vein; it emits its first branch midway between the first two branches of the scapular vein; this forks at least once, but probably only once, at less than half way to the apex; a second branch, not shown on the plate, and obscure upon the fossil, arises opposite the fifth internomedian branch, but only its base is preserved. The internomedian vein, so far as it is clearly preserved, is straight, and considerably oblique, being parallel to the general trend of the middle portion of the externomedian vein, and, in this portion of its course, it emits five equally and widely distant, generally forked branches, which are oblique at origin, and excepting the first, very strongly arcuate beyond, becoming nearly longitudinal; directly beyond the origin of the fifth branch, or just at the end of the middle third of the wing, the vein itself becomes longitudinal, and runs scarcely convergent with the margin, probably ending in the middle of the apical third of the wing,[1] and thereafter emits one or two more simple branches.

The wing is of medium size, the fragment measuring 19 mm. in length and 10 mm. in breadth; probably the entire length of the wing was 25 mm., making the breadth to the length as 1 : 2.5. The upper surface of a left wing is exposed, and the more essential parts of the neuration are present, although the entire anal area, with the corresponding upper portion of the base, is gone, together with a large fragment from the apex of the wing. The most characteristic feature in the wing, one found apparently in no other palaeozoic cockroach, is the peculiar limitation of the cross neuration to broad, piceous belts, which follow the veins and their branches throughout all parts of the wing sufficiently preserved to see it, excepting the branches of the mediastinal vein; they are apparently worn from all but the basal portion of the scapular and externomedian veins, to the extent represented in the plate; but, wherever they can be seen, follow each of the veins and their branches with extreme regularity and nearly equal width, so as to cross the interspaces where these are narrow; the cross veins in these belts are very delicate, crowded, elevated, a little irregular, but usually transverse to the interspaces, and only to be seen by the aid of a magnifier; between the bands, which are about 0.75 mm. in breadth at the widest, no

[1] The outside mark on the plate (fig. 9), representing the termination of the internomedian area, should therefore be removed considerably further toward the tip of the wing.

trace of transverse markings can be seen. This peculiar structure is well brought out in fig. 16ª, of Fontaine and White's plate, but the figure of the wing, fig. 16, represents the course of the neuration as entirely wrong.

The species is, of course, based upon the wing described above, but another fragment of a wing (Pl. 6, fig. 10) has been found by Professor Fontaine; and, notwithstanding it occurs in a considerably lower deposit, and represents a part absent from the other wing (thus supplementing it, but at the same time affording no common ground for structural comparison beyond the size), we must consider it as belonging to the same species, on account: first, of its size, which agrees perfectly with the other fragment; and second, from the fact that each of the veins is accompanied by a black belt, although without the addition of the transverse veins. The fragment is that of an entire anal area, and shows that the anal furrow of this species was very deeply impressed in its basal half, more gently in its apical, was rather strongly arcuate and a little bent in the middle, but probably terminated a little beyond the middle of the basal half of the wing, being unusually short: the anal veins were simple, the first three rather distant (but the first very close to the anal furrow), scarcely raised above the surface, and bent in the same sense as the anal furrow, being subparallel to it; the other three or four are gently arcuate in an opposite sense, delicately elevated, and closely crowded. The length of the fragment is 7.5 mm.; its breadth, 3.5 mm. The black belts accompanying the veins are a little narrower than in the other fragment. The surface exposed is also that of a left upper wing.

This species is sufficiently distinguished by the banded neuration of the wings to separate it from any other. The distribution of the veins, however, shows that it falls into this genus and has certain special affinities with *Gerabl. Mahri* and *G. weissiana*; from the former of these it differs very much in the greater brevity of the mediastinal area and from the latter it is distinguished (there are few points of comparison, from the fragmentary nature of *G. weissiana*) by the much earlier origin of the first scapular branch. It has closer affinities, in most of the broad features of its neuration, with the other American species of the genus, *G. fasciata*, but to the fine subdivision of the veins of the latter it has nothing to correspond; neither has it in the length and multiple division of its scapular vein, nor in the basal union of the principal veins, nor in the structure of the anal area.

The first and principal fragment described above was found by Messrs. Fontaine and White at Cassville, Monongolia County, W. Va., in the roof shales of the Waynesburg coal, or the very highest of the beds of the upper productive coal series, in the nomenclature of the first Pennsylvania survey, or the beds termed Permo-carboniferous by Professor Fontaine. The other fragment comes from Bellaire, Ohio, near Wheeling, W. Va., associated with plants of the upper productive coal beds, in shales twenty feet below the Pittsburgh bed of coal, which lies at the base of the upper productive coal series, and clearly within the carboniferous series proper. Professor Fontaine, who kindly sent me the specimens, writes me that the two localities are eighty miles apart, and separated by three hundred feet of strata. Upper carboniferous; Permo-carboniferous.

Cerablattina fascigera. Pl. 6, figs. 1, 2.

Blattina fascigera Scudd., Proc. Bost. soc. nat. hist., XIX, 238–39; — Ib., Entom. notes, VI, 35–36.

Fore wing. The wing is broad and nearly equal, the humeral lobe full, the costal margin very gently and very regularly convex, the inner margin nearly straight until the apical third of the wing, where it is roundly bent and thus narrows the well-rounded apex; the veins originate below the middle of the wing, and all but the mediastinal and the anal veins from a single root considerably below the middle, from whence they curve rather strongly upward. The mediastinal vein is very faintly preserved, and runs subparallel to the costal border, with a similar arcuation, to the middle of the apical half of the wing, and then curves toward it and meets it at the extremity of the fragment, or beyond the middle of the apical fourth of the wing;[1] it emits a very great number of closely crowded branches, which are only visible in the apical half of the area, nowhere visible throughout their length, both their bases and even the principal vein itself being obliterated, and the course of the vein only indicated by the position of their outer extremities; enough remains to show that they are generally simple (in a single instance a fork is seen), straight or faintly arcuate, the convexity away from the costal margin and oblique, the apical ones becoming slightly longitudinal; in the middle of the wing the area occupies somewhat less than one-fourth the breadth of the wing. The common stem from which arise the scapular, externomedian, and internomedian veins and the anal furrow, runs in a straight line parallel to the nearly obliterated mediastinal vein until just past the middle line of the wing, at about the middle of the basal third of the wing, when they all divide simultaneously, excepting the two lower, which do not separate at once from each other. Beyond this common point of departure, the scapular vein is at first gently arcuate, shortly afterwards, after its first branch, nearly straight, running throughout parallel to the costal margin, but at a wide distance from the mediastinal vein, and terminates at the tip of the wing; it is, however, slightly arcuate, in an opposite sense to its first arcuation, between each pair of branches, the main stem and each branch appearing, almost equally, as forks of the preceding part of the main stem; these branches are four in number; the first differs from the rest; it parts from the main stem a little beyond the basal third of the wing, soon becomes nearly longitudinal, but gradually approaches the mediastinal vein, and finally forks, the two branches of the fork closely resembling branches of the mediastinal vein; the second branch of the scapular vein arises a little beyond the middle of the wing, the fourth midway between this and the apex, and the third midway between the two; the second is doubly, the third simply forked, and the fourth simple; the apical shoots of these branches strike the margin of the scapular area at increasingly wider intervals, the lower interspaces being similar in width to those of the inner margin. The externomedian vein, beyond the point of common origin,[2] runs in a nearly straight but faintly wavy course nearly along the middle of the wing, parallel to the preceding, and has similar arborescent but inferior branches, also emitted at irregular intervals; the first, which is doubly forked, is emitted at the centre of the wing; the second and third, which are sim-

[1] The mark separating the mediastinal and scapular areas is placed a little too far toward the apex in the plate.

[2] Represented on the plate a little incorrectly, as it should be united at its base with the scapular vein.

ple, are thrown off, one opposite the first fork of the first branch, the other opposite the last branch of the scapular vein; there is also the commencement of an oblique, stout cross-vein opposite the basal branch of the scapular vein, running half way to the second branch of the internomedian vein, almost precisely similar to what occurs in *Etobl. venusta* and in *Arch. acadicum*, both, like this, American species, and members of the same subfamily. The internomedian vein and anal furrow part from each other almost immediately after their common departure from the united vein, and the internomedian then runs in an irregularly straight line, subparallel to the externomedian vein, and terminates a little farther from the tip than the mediastinal vein; it curves downward a very little at the origin of its third branch, so as to be a little more distant from the externomedian between its third and fourth branches than before; it has in all five branches, which originate at subequidistant intervals, the last of which is simple, the others more or less deeply and simply forked; they are all more or less arcuate and somewhat longitudinally oblique. The anal furrow, from the common origin of all the veins, is straight, very deeply impressed on the basal half, somewhat longitudinally oblique, and terminates in the middle of the inner margin;[1] the anal veins are very independent of the anal furrow, consisting first of a pair of compound veins arising from the extreme base of the wing at the origin of the common stem of the principal veins, and running in an obliquely longitudinal course to strike the apical half of the margin of the anal area, and leaving a wide interval at the base between them and the common stem and the anal furrow; and in the angle four closely approximated, straight, similarly oblique, simple veins.

The wing is a large one, measuring 35 mm. long as far as preserved, and 15.5 mm. broad; the entire length of the wing must have been 38 mm., and the proportion of the breadth to the length as 1 : 2.5. The wing is perfect, except a slight fragment of the tip and a little piece of the base of the anal area. The specimen shows the upper surface of a left wing. The surface is covered with a very delicate network of raised veins, which are arranged more or less irregularly, transverse to the interspaces, in a broad marginal band around the apex and inner border of the wing, and as an entirely irregular polygonal reticulation upon the disc; no network can be seen, probably from poor preservation, upon the mediastinal area.

This species was wrongly compared by me to *Etobl. primaeva*, with which it has very few special points in common, and from which it is widely distinct in the structure of the mediastinal and anal veins. It seems to belong certainly in the genus Gerablattina, but forms perhaps a distinct section, differing from all others in the extreme multiplicity of the mediastinal branches, in the basal coalescence of the other principal veins, in the arborescent division of the scapular and externomedian veins, and in the longitudinality and dichotomy of the anal veins, and their wide separation from the anal furrow. In the broad features of its neuration, however, and particularly in points of division of the scapular, externomedian, and internomedian areas, it resembles most and to a considerable degree the only other American species of the genus, *G. balteata*, but it differs from it in all the points above mentioned, and in lacking the banded ornamentation of the veins.

The single specimen found was obtained by Mr. R. D. Lacoe, at Pittston, Penn., and lies on a piece of black carbonaceous shale coming from the interconglomerate beds of the true

[1] The termination of the anal area is marked in the plate on the wrong side of the anal vein.

coal measures at the anticlinal next north of that in which the Pittston species of Lithomylacris occur, and also on the south-east side. Lower carboniferous.

Hermatoblattina nov. gen. (ἕρμα, Blattina).

Blattina Auct. (pars).

The two species which form this genus differ in the nature of the mediastinal area in the front wings; in one it is nearly one-third the breadth of the wing, equal nearly to the extremity, and terminates close to the tip of the wing; in the other it is fully a third the breadth of the wing near the base, and diminishes regularly to the extremity, which is somewhat beyond the middle of the outer half of the wing; in both the vein is gently sinuous and the branches frequent, oblique and generally simple. The scapular vein, although beginning to branch before the middle of the wing, has only two or three branches, which are inferior, diverge but slightly, and may or may not fork, so that the area occupied by the vein is slight, and terminates at the tip of the wing. In consequence of the inferior position of the branches, the equal interspace between the mediastinal and scapular veins is marked by oppositely diverging branches. The externomedian vein is very similar to the scapular in extent, place and mode of branching, but the branches may be either superior or inferior, but always fall upon the margin below the apex of the wing. The anal and internomedian areas are very broad at base, occupying more than half the breadth of the wing, but narrow rapidly, the internomedian being considerably arcuate, and terminating not very far from the apex; the branches of the externomedian are as oblique as those of the mediastinal area, and although very long and straight, fork very little. The anal furrow is not very pronounced, more or less arcuate, and terminates not far beyond the basal third of the wing; the anal veins are subarcuate, subparallel, frequent and simple. Nothing is known of the genus but front wings, which are unusually stout, the breadth being contained in the length scarcely more than two and a quarter times; with the possible exception of Petrablattina, the average form is stouter than in any other genus, although other genera contain stouter species.

This genus is peculiar for the inferior position of the branches of the scapular vein, a characteristic it shares only with Oryctoblattina, from which it is readily separated by the slender development of the same vein, and by the different nature of almost all of the others. But for the inferior position of these branches of the scapular vein, it could hardly be separated from Gerablattina. From Archimylacris and Etoblattina it is distinguished by the breadth and extent of the mediastinal area. From Anthracoblattina it is again separated by the inferior position of the scapular branches. The limited extent of the combined areas of the scapular and externomedian veins readily distinguish it from Progonoblattina, while the totally different nature of the externomedian vein in Petrablattina permits of no confusion with that.

The two species belonging here come from the old world, and are of large size.

Hermatoblattina wemmetsweileriensis. Pl. 4, fig. 14.

Blattina wemmetsweileriensis Gold., Faun. saraep. foss., ii, 19, 24, 51, taf. 1, fig. 9.

Fore wing. The wing is broad and nearly equal, almost imperceptibly diminishing in size up to the apical fourth of the wing;[1] the costal margin is very gently and regularly

[1] This scarcely appears on our plate, where the apical half of the costal margin is a trifle too full.

convex, the inner margin straight, and the apex well rounded, no doubt, but broken in the specimen. The veins probably originate a little above the middle of the wing, and are gently arcuate at their base. The mediastinal vein runs parallel to the costal margin, but beyond the middle of the wing scarcely recedes from it, afterwards curving very slightly upward, and striking the apical border not a great way above the tip of the wing; it emits a large number, thirteen or more, of rather frequent branches, most of which are simple (the penultimate doubly forked), parallel, the earlier ones oblique, the later longitudinally oblique; the area is a little more than a fourth the width of the wing in the middle. The scapular vein runs closely parallel to the mediastinal throughout its course and emits, at equal distances apart, three inferior, apically forked branches, the first scarcely beyond the basal third of the wing, the third somewhat before the end of the middle third of the wing, and all with their forks crowded closely together into the space between the tip of the mediastinal vein and the extreme apex of the wing. The externomedian vein, on the other hand, runs close and parallel to the internomedian vein; but it also has three branches, which are slightly further apart thanin the preceding, but originate almost exactly opposite them, the last simple, the others compound, filling the area with veins as closely crowded as in the preceding area; the branches being superior while those of the scapular area are inferior, brings the branches opposed to each other in a sense the reverse of what is commonly found in palaeozoic cockroaches, and gives the wing a peculiar appearance. The internomedian vein is gently and decreasingly arcuate from the base outward, and is very regular, but, at the origin of its last branch, takes a direction a little above its former course, the branch and the apex of the vein making common forks of the preceding part of the stem; it terminates before the apical sixth of the wing, and emits eight equidistant, simple or forked, straight veins, all but the last of which are oblique; the vein originating above the middle of a broad wing, and extending so far toward the tip, gives this area a great extent, making it not a little remarkable that some of its basal branches, all of which are more distant than the mediastinal branches, should be simple, and so very straight. The anal furrow is apparently deeply impressed at base, pretty regularly and very strongly arcuate, terminating a little beyond the basal third of the wing; the anal veins, nine in number, are, so far as preserved, simple, straight, and closely crowded toward the inner angle, gently arcuate and more distant next the anal furrow.

The wing is a large one, the fragment measuring 34 mm. in length and 16 mm. in breadth; the length of the wing can vary little from 37 mm., making the breadth to the length as 1 : 2.3. It is almost completely preserved, a little of the extreme base and tip only wanting. If the upper surface is exposed, the wing is from the right side; the reticulation is mostly effaced, but with a lens one may see exceedingly delicate transverse wrinkles, giving the wing a shagreened appearance.

Goldenberg compares this species with *Etobl. primaeva*, with which, however, at least above the internomedian area, it has very little in common, and from which it differs greatly in shape; the other species of the genus agrees far better with *Etobl. primaeva*. This species differs from *Herm. lebachensis* in the structure of the mediastinal area, which is here almost equal, and in the distribution of the externomedian branches, which are superior and not inferior.

The single specimen was found in a bluish bituminous shale in the neighborhood of Wemmetsweiler, near Saarbrücken, Germany. Upper carboniferous.

Hermatoblattina lebachensis. Pl. 4, fig. 11.

Blattina lebachensis Gold., Sitzungsb. math.-nat. Cl. k. Akad. Wiss. Wien., IX, 38 (undescribed).

Blattina lebachensis Gold., Palaeontogr., IV, 22, 23, taf. 6, fig. 7; — Ib., Foss. Ins. Saarbr. 6, 7, taf. 4, fig. 7; — Ib., Faun. saraep. foss., ii, 20, 27, 51, taf. 1, fig. 20; — Gieb., Ins. Vorw., 316; — Gein., Geol. Steink. Deutschl., 150.

Fore wing. The extreme base and a considerable part of the apex of the wing being lost, its form cannot be given in detail; but it is remarkable for its great breadth near the base, due to the unusual convexity of the basal half of the costal margin, which is a little exaggerated in the plate; beyond this fulness the costal margin is straight, and gradually approaches the inner margin, which is itself very gently and regularly convex, so that the wing tapers considerably beyond the basal third. The veins appear to originate not far from the middle of the base, perhaps a little above it, and have a long basal arcuation. The mediastinal vein is very broadly and gently sinuous, straighter than the costal margin, so that the mediastinal area, which terminates just at the tip of the fragment, and probably not much before the apical sixth of the wing, narrows toward either extremity from the middle of its basal half, being at its broadest about one-third the width of the wing; it emits eight distant, straight branches, all excepting one which is forked, simple, the basal one transversely, the apical ones a little longitudinally oblique. The scapular is throughout close and parallel to the mediastinal vein; it seems to be coalesced with the externomedian vein in the basal fourth or third of the wing, and to have three inferior, simple, longitudinal, arcuate, apically distant branches, the first arising beyond the basal third of the wing and reaching the extreme tip, the last arising at about the end of the middle third of the wing. The externomedian vein is very broadly and gently sinuous, running down the middle line of the wing, terminating just below the tip, and emitting three inferior, simple, gently arcuate, sublongitudinal, apically distant branches, arising almost opposite those of the scapular vein. The internomedian vein is strongly and regularly arcuate, apically straight or slightly arcuate in a reversed sense, terminating about opposite the end of the mediastinal vein, and emitting half a dozen rather closely approximate, very long, oblique, straight or sinuate simple branches, the penultimate, in the individual figured by Goldenberg in his Fauna saraepontana, ending in the preceding branch.[1] The anal furrow is lightly impressed, gently convex, and terminates a little before the middle of the wing; the anal veins, five or six in number, are simple, not very closely crowded, and similarly arcuate.

The wing is a large one, the fragment measuring 28.5 mm. in length, and 16 mm. in breadth; the length of the wing may be anywhere from 32 to 36 mm., so that the breadth is to the length as 1 : 2 – 2.25. The wing is from the left side, and the upper surface is exposed; the recticulation of the wing is composed of polygonal, mostly tetragonal or pentagonal, cells, forming a network which may be seen with the naked eye, and are more delicate on the disc than near the apex.

[1] In his first description, Goldenberg describes the six internomedian branches as all simple excepting the fourth, which is forked; and he figures them as all simple and running to the margin excepting the third, which is forked. In his second description, based apparently on the same specimen, he describes them as all simple and figures them as we have here described.

Goldenberg compares the species to *Etobl. euglyptica*, from which he says it differs in its larger size, broader mediastinal area, larger number of branches in the anal area, and a wider interspace between the scapular and internomedian areas. The differences between the two species in every part of the wing are so great that it is difficult to see any special point they have in common, excepting the simplicity of the internomedian and anal branches, which is common to a great number of forms. Goldenberg subsequently compares this species to *Etobl. anaglyptica*, with which it agrees better both in shape and in neuration, but it is still larger than that species, and differs besides in the brevity and non-production of the internomedian area. It much more closely resembles *Etobl. primaeva* than either, although still widely distinct from it. From the only other species of the genus it is distinguishable by the brevity and unequal breadth of the mediastinal area, the inferior origin of the externomedian branches, and the tapering form of the wing.

Several specimens must have been found in the iron-stone nodules of Lebach above Saarlouis, Germany, as Goldenberg remarks that it appears there to be common. Dyas.

We come now to the more aberrant forms of this group of carboniferous cockroaches, the preceding genera being more closely allied to each other than to either of the groups which are to follow, and which comprise between them but five species.

Progonoblattina nov. gen. (*πρόγονος*, Blattina).

Blattina Auct. (pars).

In the genus now under consideration the mediastinal vein of the front wing runs parallel and near to the costal border, occupying, even in the slender species, less than a third of the breadth of the wing, and terminating only a little beyond the middle of the costal margin; its branches are frequent, oblique, gently arcuate, and simple. The scapular vein is of much greater importance, commencing to branch far toward the base of the wing, emitting five or six forking branches, and terminating only just before the tip of the wing; the branches are superior, but longitudinal or scarcely oblique, and at the termination of the mediastinal vein the are aoccupies about half the breadth of the wing. The externomedian vein early divides into several principal branches, which are very similar in nature to those of the preceding vein, and occupy on the margin a similar extent; according, however, to the curve of the main scapular vein, this area may occupy, with its many doubly forking longitudinal branches, more or less room than the scapular area; together they occupy the entire apical half of the wing, and more than a third of the basal half. The internomedian vein, which originates in the middle of the base of the wing, slopes in a more or less arcuate curve toward the middle of the inner margin; it emits only three or four branches, simple or apically forked, and altogether plays a very insignificant part in the wing, the anal furrow, which is slight and considerably more arcuate than the internomedian vein, terminating beyond the middle of the basal half of the wing. The anal veins are more oblique than the anal furrow, not very numerous, subparallel, and simple or forked.

Nothing but upper wings are known, and these vary exceedingly in slenderness, one of the two species being the slenderest known species, while the other is a little below the general average.

This genus is readily separated from all the preceding by the much greater common expanse of the scapular and externomedian veins, and the unimportance of the internomedian area; indeed, in these particulars it surpasses any of the ancient genera of cockroaches. From Oryctoblattina it is readily separated by the brevity of the mediastinal area, and by the approximation of all the veins in the basal half of the wing. The totally different character of the externomedian vein distinguishes it from Petrablattina, although it approaches that genus in the abundance of the neuration.

The two species, which differ widely from each other, are European; one of them is a large species, the other rather small.

Progonoblattina helvetica. Pl. 3, fig. 10.

Blattina helvetica Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 287, 291–93, pl., fig. 1; — Ib., Urw. Schweiz., 592, note; —Ib., Monde prim. suisse, 22, fig. $16c^{ab}$; — Gold., Faun. saraep. foss., ii, 19.

Blatta helvetica Heer, Prim. world Switz., I, 20, fig. $16c^{ab}$.

Fore wing. The wing is pretty regularly elongate-obovate, the costal and inner margins about equally and considerably convex, the apex tapering but well rounded. The base of the wing is broken, especially next the margins, so that the mediastinal vein can be traced only a short distance; here it runs near and parallel to the margin, and by a gentle curve strikes it at the end of the middle fifth of the wing; the width of the area is less than a sixth that of the wing, and in the portion preserved only a couple of branches are seen, widely separated at their origin, simple and arcuate, but brought near together by their unusual longitudinality, so that it is doubtful if there are more than five or six branches to the vein. The following areas, as Heer has pointed out, are difficult to separate, from the fact that the base of the wing is lost, and they all divide so early as to exhibit at the edge of the fragment, very near the base, no less than eight nervules between the mediastinal vein and the anal furrow. It would, however, present a structure so abnormal were any but the nervure next the anal furrow to belong to the internomedian vein, that it seems almost certain that we must divide seven of them between the scapular and externomedian veins; the three lower of these have an oblique course at the base, and are separated by an unusual width from the upper four, which in their turn have a longitudinal course; and these two bundles of nervules we may consider as belonging to the externomedian and scapular veins respectively. On this assumption the scapular vein is longitudinal and nearly straight, and terminates just above the extreme tip of the wing; it has six longitudinal branches, three of which originate within the basal quarter, two near the middle and one next the tip of the wing; the first and last are simple, the others simply, the middle one doubly forked; the basal branches curve very gently upward toward their tip, but the others are wholly horizontal. The externomedian vein is more difficult to define; the three veins with which it starts from the base of the fragment are very similar in character, and being perfectly parallel next the edge (which must lie within the basal fifth or sixth of the wing) it is not clear which should be looked upon as the main stem; but the main stem may be said to break close to the base into three branches which run close together toward the middle of the outer half of the inner edge of the wing; omitting the upper branch of the upper vein, each of these three stems forks at or just beyond the end of the basal third of the wing, and each of these forks again divides at irregular

distances from this point, but most of them not far from the end of the middle third of the wing; the upper stem, however, has an upper branch, which starts in the middle of the wing and is doubly forked, running in a very straight, longitudinal course almost exactly through the middle line of the wing, its first fork near the end of the middle third, the second near the tip of the wing. The internomedian vein is scarcely arcuate, and by an apical fork is thrown a little further out than it otherwise would be, reaching close to the end of the middle third of the wing; besides the apical fork it has three branches, emitted near together, not far from the end of the basal third of the wing, straight, oblique and apically forked. The anal furrow is not impressed, regularly and considerably arcuate, bears an inferior, nearly straight branch near the middle of its preserved course, and terminates considerably beyond the basal third of the wing; the anal veins are scarcely so crowded as the others, simple, forked or compound, arcuate, and subparallel to the anal furrow.

The wing is a very large one, the fragment measuring 39 mm. in length, and 17 mm. in breadth. The probable length of the wing is 42 mm., making the ratio of the breadth to the length as 1 : 2.5. The wing is from the left side and shows the upper surface, which is covered with a network of very numerous, closely crowded, delicate cross veins, visible only by aid of a glass. Heer compares the species with *Etobl. primaeva* and *Etobl. didyma*, but fails to point out its closer alliance to *Progon. Fritschii*, which he describes immediately afterwards, or to notice the feature which is most characteristic of it, viz., the exceedingly early division of the scapular and externomedian branches, and the nearly uniform longitudinal course of all these branches; no other palaeozoic cockroach has such an abundance of longitudinal veins filling the larger part of the wing. From its congener it is readily distinguished by this feature, and also by the smaller extent of the scapular area as compared to the externomedian, and the far greater size and stoutness of the wing.

A single specimen, found in the anthracitic schists of the lower quarry of Erbignon, Canton Wallis, Switzerland, is remarkable as the only animal yet discovered there. Middle or upper carboniferous.

Progonoblattina Fritschii. Pl. 3, fig. 12.

Blattina Fritschii Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 287, 293–94, pl., fig. 2;—Gold., Faun. saraep. foss., ii, 19.

Fore wing. The wing is exceptionally slender and equal, both borders being almost perfectly straight; the apex and outer half of the inner margin are lost, but the part preserved is more than three times as long as broad. The veins originate just above the middle of the base of the wings, and have the slightest possible upward curve in passing outward. The mediastinal vein runs subparallel to the costal margin, but always almost imperceptibly approaching it, more rapidly toward the tip, which strikes the margin at the end of the fragment, or a little beyond the middle of the wing; in the middle the area is a little less than one-third the width of the wing, and it is occupied by about seven longitudinally oblique, slightly arcuate, simple veins. The scapular vein runs close beside the mediastinal through the basal quarter of the wing, then turns abruptly although only slightly from it, and runs in a broad, arcuate curve past the middle line of the wing, to strike the border just above the tip, or where a continuation of its basal course would have brought it; it has five superior, obliquely longitudinal branches, the first emitted at the

point where it diverges from its first course, which is doubly forked; the next, which is forked, at the end of the basal third of the wing; and three simple, more closely approximated veins, at and a little beyond the middle of the wing. The externomedian has an arcuate course, closely parallel to the scapular vein, through the basal third or thereabouts; here it is broken up into three principal stems, the upper of which runs in a slightly arcuate course to a point as far below the extreme apex as the scapular vein is above it, emitting in the apical third of the wing three simple, nearly longitudinal branches, which occupy the apex of the wing; the middle stem runs close to the preceding, and emits, at one-third and two-thirds way to the border, two superior, simple, straight, and nearly longitudinal branches; the lower is basally forked, the forks resembling the basal branch of the middle stem. The internomedian vein is rather gently and regularly arcuate, terminating next the middle of the lower border; it has three simple branches, and one (the first) forked branch, approximate, straight, and oblique. The anal furrow is a little more strongly, but just as regularly arcuate, and strikes the margin at the end of the basal third of the wing; the anal veins, four in number, are simple, distant, slightly divergent, and similarly arcuate.

The wing is of medium size, but appears rather small from its narrowness, the fragment measuring 22 mm. in length and 6.5 mm. in breadth;[1] the wing must have measured 23.5 mm. in length, so that the breadth was to the length as 1 : 3.6. If the upper surface is preserved, it is from the left side. It is very nearly perfect, only a portion of the tip and lower apical margin being lost. The reticulation between the veins is mostly destroyed, but with a glass one may see, particularly in the anal area, excessively delicate wrinkles or little streaks, giving a shagreened appearance to the wing, and indicating the presence of closely crowded cross neuration.

Heer remarks that this species comes next to *Gerabl. Münsteri*, but it differs more from that than from many other species, such as *Etobl. flabellata* and *Etobl. affinis*; but even from these it is widely different in the distribution of the scapular and externomedian branches. From its single congener, *Progon. helvetica*, it is readily distinguished by its exceedingly different size and shape, and differs also in its broader mediastinal field, the less basal division of the scapular and externomedian veins, and the more oblique course of the scapular branches. Indeed, it differs so much from it, that were it not for its essential agreement in the points in which they both differ from the other palaeozoic cockroaches, it would seem more rational to separate them generically; which a more extended acquaintance with palaeozoic Blattinarians may yet compel us to do.

One specimen, from the coal-measures of Manebach, near Ilmenau, in Thüringen. Upper carboniferous.

Oryctoblattina nov. gen. (ὀρυκτός, Blattina).

Blattina Auct. (pars).

The mediastinal vein of the front wings runs parallel and very close to the costal margin, closer than in any other of the genera here described, and terminates only a little before the middle of the outer half of the wing; it emits numerous branches almost transverse to the wing in the basal portion, but notwithstanding their brevity often forked in this part of the area. The scapular vein is very peculiar; it begins to branch a little beyond the

[1] Heer says 7.5 mm., but his figure represents it as if it were 6.5 mm., and this is more likely to be correct.

middle of the basal half of the wing, and the main stem terminates on the costal margin a little beyond the middle of the apical half of the wing, keeping widely distant from the mediastinal vein throughout its course; it emits numerous parallel, straight, longitudinal and forking branches, most of which, in the only species known, originate from a vein parallel to the main stem, which is emitted abruptly from near the base of the second branch; the first branch terminates at the extremity of the inner margin, so that the entire apex of the wing belongs to the scapular area, which is the largest in the wing. The externomedian vein branches near the middle of the wing, and before that is equally separated from the neighboring veins by a wide space; it has only two or three branches which are superior, and perhaps simple, and they occupy a very restricted area, only the apical fourth of the inner margin being covered by their extremities. The internomedian vein is again very peculiar, this being the only genus known in which a wide space intervenes between the anal furrow and the branches of this vein; it assumes to a considerable degree the form of the externomedian vein, first branching beyond its middle, and then emitting a very few simple or forking, but inferior branches. The anal furrow is conspicuous, very arcuate, originating in the middle of the base of the wing, and terminating in the middle of the basal half of the inner margin; it is rendered more conspicuous by the fulness of the anal area, which breaks the regular continuity of the margin at the extremity of the anal furrow, a peculiarity occurring in no other carboniferous cockroach; the anal veins are very few, sinuous, subparallel, simple and oblique. The wing is of the average slenderness, the breadth being contained in the length about two and six-tenths times. Nothing is known of other parts of the body.

This most exquisite of the carboniferous cockroaches is very widely separated from the rest. The peculiarities of nearly every part of the wing separate it at once from nearly every other genus; the extreme narrowness of the mediastinal area, the wide separation of the main veins from one another (accounted for perhaps by the excessive development of reticulation), the independence of the internomedian vein, and the fulness of the inner margin in the anal area, occur nowhere else; the inferior origin of the branches of the scapular vein are found elsewhere only in Hermatoblattina, and the wide extent of the area occupied by the combined scapular and externomedian branches are reproduced only in the aberrant genera among which it is placed. From Progonoblattina it is separated by the small space, and that wholly on the inner margin, which is allotted to the externomedian veins, besides the points first mentioned; and from Petroblattina, its other nearest ally, it is conspicuously distinct both by the nature of the externomedian vein, and by the wide separation of the main veins in the basal half of the wing.

The genus is only known from Europe, and is the only one represented by a single species, which is of rather small size. More than twenty years ago Giebel suggested that this species should form the type of a distinct genus.

Oryctoblattina reticulata. Pl. 4, fig. 13.

Blattina reticulata Germ., Verst. Steink. Wettin, vii, 87–88; viii, taf. 39, fig. 15ª, 15ᵇ; — Gieb., Deutschl. Petref., 637; — Ib., Ins. Vorw., 316; — Gold., Faun. saraep. foss, ii, 19.

Fore wing. The wing is of a very graceful form, oblong obovate, the costal margin tolerably convex next the base, with a very slight humeral lobe, beyond very gently and

regularly convex; the inner margin is straight, excepting for the fulness of the anal area, but a large fragment of the apex of the wing is wholly lost. The veins originate from a little above the middle of the base, and have a gentle basal arcuation. The mediastinal vein runs in close proximity and subparallel to the costal margin, constantly but very gradually approaching it, emitting numerous oblique branches; in the basal half of the area the branches are forked half way to the margin, and between the forks are other parallel, spurious branches; but beyond the middle of the wing spurious and forked branches become alike very closely crowded, oblique, simple branches, which continue along the edge, between the apparent termination of the main vein (about the end of the middle fifth of the wing) and the scapular vein; in the middle of the wing the area is only about one-tenth the width of the wing. The course of the scapular vein has been described sufficiently under the generic description; it will be sufficient to add here that there are about half a dozen longitudinal shoots to the offshoot of the second scapular branch, and that these become more and more closely crowded toward the costal margin; and that the two principal branches of the scapular vein originate close together, the second forked at some distance beyond the offshoot. The externomedian vein is gently arcuate in its basal half. The internomedian vein closely resembles it, and in this particular this species is widely separated from all others; but it is a little more arcuate, has inferior instead of superior branches, and terminates about the middle of the apical half of the inner margin. The anal furrow is distinct and arcuate, bending downward to the margin more rapidly than usual; the anal veins are only three in number, crowded close together in the middle of the area, traversing it obliquely, with a slightly sinuous, obliquely longitudinal course.

The wing is one of the smaller of the medium-sized ones, the fragment measuring 19 mm. in extreme length and 8.5 mm. in breadth; it represents a wing of the same median breadth and a length of about 22 mm.; so that the breadth to the length must have been as 1 : 2.6. The wing is from the left side. It is marked by a distinct and exceedingly delicate and perfect reticulation of mostly pentagonal cells, two or more rows being seen between the wider interspaces; but in the narrower ones, as between the closely approximated scapular branches, these are reduced to a single series of tetragonal cells, formed by single, transverse raised lines, as far apart as the interspaces, but still no smaller than the pentagonal cells; next the border, between the extremities of the mediastinal and scapular veins, these cells form, by the absence of their cross bars, spurious veinlets as long as the apical width of the mediastinal area; between the anal furrow and the nearest internomedian branch they do the same, but the veinlets are longer; and in the apical half of the anal area the same thing occurs on a smaller scale.

This wing is so peculiar that it can be compared with no other. Germar and Giebel both describe the scapular vein as the mediastinal, and the mediastinal as a delicate, longitudinal vein running down the middle of the mediastinal area.

The single specimen described by Germar was found at Wettin, Germany. Upper carboniferous.

Petrablattina nov. gen. (*πέτρα*, Blattina.)

Blattina Auct. (pars).

The mediastinal vein runs parallel to and not very distant from the costal margin (the area occupying perhaps one-fourth of the breadth of the wing), and terminates at some distance beyond the middle of the costal border; it is abundantly supplied with straight,

oblique, simple or forked cross-veins. The scapular vein, contiguous to, perhaps united with, the externomedian in the basal part of the wing, is of small importance, emitting in the apical half of the wing only two or three branches, which are superior, simple, or furcate, and terminate on the costal margin, the whole tip (in one species at least, and perhaps in both) belonging to the externomedian vein. The externomedian vein is the most peculiar in the wing; as soon as it is free from the common basal union of all the veins, it curves strongly backward to about the middle of the inner margin, in close proximity to the internomedian vein; and from its superior, now outer, surface emits a large number of parallel, forking veins, which terminate on the apex and outer half of the inner margin of the wing. The combined internomedian and anal areas are very broad at base, occupying fully two-thirds the breadth of the wing, and retain their breadth for some distance and then narrow with excessive rapidity, dividing about equally between them the common space; the branches of the internomedian vein are five or six in number, straight or arcuate, simple or occasionally forked. The anal furrow is very arcuate, not very prominent, and terminates near the middle of the basal half of the wing; the anal veins are frequent, arcuate, but not so strongly as the furrow, and simple or occasionally forked. Only upper wings are known.

The wings are stouter than usual, although they are not sufficiently well preserved to give any more definite statement than that they are, on the average, stouter than any other, excepting probably Hermatoblattina, and possibly Anthracoblattina.

This genus is remarkable for the close union of the veins at the base, and for the very strong curvature of the externomedian vein, by which it resembles somewhat the anal furrow, and for the contrasted longitudinality of the branches which spring from it. In these particulars it differs strikingly from every other genus, and can be confounded with none of them.

Only two species have been described, one of which is European, and the other, known only by a very small fragment of a wing, American; they are both of rather small size.

Petrablattina gracilis. Pl. 4, fig. 4.

Blattina gracilis Gold., Palaeontogr., IV, 23, taf. 3, figs. 3, 3ª; — Ib., Foss. Ins. Saarbr., 7, taf. 1, figs. 3, 3ª; — Ib., Faun. saraep. foss., ii, 20, 27–28, 51, taf. 2, fig. 1ª; — Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 288; — Gein., Geol. Steink. Deutschl., 150.
Blatta gracilis Gieb., Ins. Vorw., 321.

Fore wing. The wing is of a regular elliptical form, broadest in the middle, tapering more rapidly toward the apex than toward the base, both costal and inner margin equally and rather gently convex, the tip a little pointed, but well rounded. The veins all originate above the middle of the upper half of the base, but, excepting the anal furrow, have no basal curve. The mediastinal vein runs subparallel to the costal margin, but in a straight line, nearly to the middle of the wing, and then curves very gradually to the border, which it reaches a little before the end of the middle third of the wing; the area is a little less than a fourth the width of the wing; its basal half is filled with closely crowded, arcuate, oblique, simple branches, the apical half with similarly crowded and arcuate, longitudinally oblique, much longer, and usually forked branches. The scapular, externomedian, and internomedian veins evidently spring from a single stem, according to Goldenberg; the in-

ternomedian first separates itself from the others, but the other two appear to be united almost throughout the basal third of the wing; the scapular vein then turns obliquely downward in parting from the mediastinal vein at the end of the basal fourth of the wing, in a direction toward the middle of the outer half of the wing; but it very soon parts widely from the externomedian vein, and runs in a longitudinal, broadly arcuate course to the costal margin, just before the apical eighth of the wing; it emits three long, longitudinal, but obliquely arcuate branches, simple or deeply forked, the first before the separation of the vein from the externomedian. The externomedian vein continues the direction of the united scapular and externomedian veins, following closely the internomedian, and terminating on the inner border, about the end of the middle fifth of the wing; it emits at a wide angle about ten closely crowded, longitudinal veins, many of which fork singly or doubly, nearly all of them broadly arcuate, the upper curving slightly upward, the lower downward, and together embracing a very extensive area, including the entire apex of the wing. The internomedian vein has a bent, arcuate course, and emits about seven long and simple, sinuous, closely crowded branches, the marginal extent of this area being rather less than that of the anal area. The anal furrow is distinctly impressed, pretty regularly and very strongly arcuate, striking the margin at about the end of the basal third of the wing; the anal veins, nine in number, are closely crowded, arcuate, and simple.[1]

The wing is below the medium size, measuring 18.5 mm. in length and 7.5 mm. in breadth; a little of the base, however, is destroyed, which would add about 1.5 mm. to the length, making it 20 mm. long,[2] and the breadth to the length as 1 : 2.6. The wing is from the right side, the upper surface exposed, with a swollen anal area; from the condition of its preservation, it cannot be determined whether there is any interspacial reticulation.

Goldenberg compares this species to *Etobl. anaglytica* and to "*Blattina formosa* Heer" from the Lias, but I fail to see the slightest ground for any special comparison; certainly not with the latter; while the peculiar basal connection of the principal veins, and, above all, the distribution of the externomedian branches, forbid comparison with any palaeozoic form, excepting the following species, from which it differs greatly in the multiplicity of its branches and in its slenderer form. Indeed, in the crowded condition of its venation it alone of all the palaeozoic cockroaches, excepting *Etobl. insignis*, shows any tendency toward a thickening of the membrane of the wing, which often appears, in ancient types, to have commenced by the multiplication of nervules.

The single specimen known comes from an ironstone nodule from Lebach, above Saarlouis, Germany. Dyas.

Petrablattina sepulta. Pl. 6, fig. 7.

Blattina sepulta Scudd., Proc. Amer. assoc. adv. sc., XXIV, B, 111, fig. 2; — Ib., Can. nat. [n. s.] VIII, 89–90, fig. 1; — Ib., Ins. carb. Cape Breton [p. 2] fig. 1.

Fore wing. The wing is so fragmentary that it is impossible to say anything more of the form than that the middle of the costal and inner margins are gently convex, the former nearly straight. The veins would appear to have originated considerably above the middle of the base. The mediastinal area occupies in the middle of the wing consid-

[1] One is incorrectly represented on our plate as forked.

[2] Goldenberg gives the breadth as 9 mm. and the proportion as 1:2.2; but his enlarged figure, presumably the most accurate, makes the breadth only 7.5.

erably less than one-fourth the width of the wing, and thereafter approaches the costal margin very gradually, terminating, presumably, just before the apical sixth of the wing;[1] in the fragment preserved it emits three longitudinally oblique, straight branches, of which the first is simple, the second simply, and the third doubly forked. The scapular vein is straight, and parallel to the costal margin, lying close beside the mediastinal vein, and, first dividing in the middle of the wing, probably terminates before the tip; its branches, two upon the fragment, are sublongitudinal, at least the first forked. The externomedian vein is strongly arcuate, curving downward to the middle of the inner margin, and emitting eight branches at a wide angle, all of them arcuate, the first nearly longitudinal, the succeeding ones gradually more and more oblique; the first must originate far toward the base of the wing, and does not fork unless near the tip, where it probably does; the next four branches are all forked near the middle of the wing, and probably fork again apically; the lower three are simple, so far as they can be traced, and probably remain so; these branches are more distant than those of the upper part of the wing. The internomedian vein is wanting, but four of its branches (perhaps all there are) can be seen, the outermost forked, the others simple, about as distant as the externomedian branches, very arcuate, and obliquely transverse.

The wing is a small one, the fragment measuring 6.25 mm. in length, and 5.75 mm. in breadth; probably the length of the wing was 13 mm. and the breadth 6 mm., making the breadth to the length as 1 : 2.2. The interspaces, particularly in the internomedian area, are filled with very frequent cross nervules. The fragment is exceedingly imperfect, not more than one-third (a middle piece) of the wing being preserved; but, excepting that it wants the anal furrow, this contains the most important part of the neuration, which differs widely from that of any other cockroach excepting the European species with which we have generically associated it; from this it differs in its presumably greater comparative breadth, the comparative sparseness of the neuration, and the downward curve of all the externomedian branches; the externomedian and scapular veins are also certainly separated much further toward the base, if not altogether, and the distribution of the scapular branches is different.

In my former description of this insect, so different is the neuration from what appears in other American species, I mistook the internomedian for an anal field, and did not attempt to interpret the other parts of the neuration. I also compared it, with no show of reason, to *Etobl. carbonaria*, with which it has no special relationship whatever.

The single specimen known was found at Cossett's pit near Sydney, Cape Breton, by Mr. A. J. Hill, C. E., together with *Libellula carbonaria* Scudd., and a frond of Alethopteris. It was kindly sent me for examination by Principal Dawson, who informs me that it comes from a rather lower horizon than that in which the Cape Breton species of Mylacris occurred, or in the lower part of the middle coal formation near the upper limit of the millstone grit. Lower carboniferous.

[1] In the plate, the line which represents the mediastinal vein in the middle of the fragment is unfortunately oblique, as if it were the continuation of the second forked mediastinal branch; instead of parallel to the margin, as it should be.

Appendix.

The following species cannot be definitely referred to any of the preceding genera.

Blattina Tischbeini. Pl. 4, fig. 10.

Blattina Tischbeini Gold., Vorw. Faun. Saarbr., 16–17; — Ib., Faun. saraep. foss., i, 16–17, pl. 2, fig. 16; — Ib., Faun. saraep. foss., ii, 19, 51.

Fore wing. The fragment preserved is an insignificant portion of the base, which does not permit us to say more of its affinities than that it belongs to the Blattinariae, and not to the Mylacridae; a network of delicate veins can be seen between the principal nervures.

Hind wing. A much larger fragment of the hind wing is preserved, consisting, however, altogether, or almost altogether, of the anal field fully expanded, but much broken and crushed out of shape, according to Goldenberg; between the veins a very fine transverse neuration is preserved, giving the wing a very delicate appearance.

A fragment of one of the legs is preserved beside the hind wing; a hind leg, according to Goldenberg, consisting of a part of the femur and tibiae "with traces of spines." This is the only palaeozoic cockroach described in which mention is made of spinous legs.

Besides these, upon the same stone but separated from them, is the pronotal shield, which, according to Goldenberg, is transversely elliptical, somewhat gibbous, the hind margin nearly straight; elsewhere, both in front and on the sides, rounded, the surface with some slight cross furrows, its length 8 mm. and its breadth 12 mm. Excepting for its hind margin, its form closely resembles that of *My'. anthracophilum*.

The species probably attained a length, according to Goldenberg, of 34 mm.

Several specimens were found in a bituminous shale at Hirschbach, near Saarbrücken, Germany. Middle carboniferous.

Blattina latinervis. Pl. 4, fig. 3.

Blattina latinervis Heer, Viertelj. naturf. Gesellsch. Zürich, ix, 288, 296–97, pl., fig. 4; — Gold., Faun. saraep. foss., ii, 20.

This is the best-preserved hind wing of a fossil cockroach known, but is still very fragmentary, nearly the whole anal field (all but a detached fragment), besides the extreme base and a belt across the middle of the wing, being wanting. It is subovate, with a straight or slightly concave costal margin and a rounded apex. The mediastinal vein, if the costal portion of the wing is perfect and correctly represented, runs close to the margin, nearly uniting with it in the middle, and then diverges slightly from it, terminating only a little before the tip, and in its apical half emitting several short, oblique branches. The scapular vein runs parallel to the border in the basal half of the wing, and then divides into two compound branches. The externomedian vein is irregular, forking near the base, the upper branch simple and running in an irregularly arcuate course to the tip of the wing, the other forked doubly, with a similar but less arcuate and more regular course. The internomedian vein emits, close to the base, two or three simple branches. The anal area, to judge from the small detached fragment, is filled with parallel, frequent, gently arcuate veins, united, like those of the other parts of the wing, with rather distant cross veins.

forming quadrate cells with the longitudinal veins, and apparently more distant in the anal area than elsewhere. The veins are everywhere edged with black. Length of fragment, 27.5 mm.; breadth, 10 mm.

Heer suggests that this may be the under wing of *Gerabl. clathrata*, but the unusual width of the mediastinal area in the front wing of that species does not harmonize well with the narrowness of the same area in this hind wing; and it is hardly probable that we shall ever be able to determine where it does belong.

A single specimen, from the coal-measures of Manebach, near Ilmenau, Thüringen. Upper carboniferous.

Blattina venosa. Pl. 4, fig. 6.

Blattina venosa Gold., Faun. saraep. foss., ii, 19, 25, 51, pl. 1, fig. 7.

This species is based upon a single fragment from the middle of a wing, whether front or hind can scarcely be determined. Goldenberg says it is of a front wing, but there appears to be no reason for his conclusion. There are a pair of branching veins, the main stems running parallel to each other, and the branches divaricating on opposite sides. Goldenberg says the veins are remarkable for their distinctness, and therefore as he makes no mention of any reticulation or cross venation, there probably is none; the openness of the neuration, with the undeviating course of the branches throughout the rather large fragment, indicate a large species. The two principal veins represented would appear to be the scapular and externomedian; or, perhaps, the externomedian and internomedian. Length of fragment, 18 mm.; breadth, 12 mm.

The single specimen was found in a soft, yellowish shale near Wemmetsweiler, in the neighborhood of Saarbrücken, Germany. Upper carboniferous.

On Pl. 6, figs. 11 and 13, are represented two fragments of wings probably belonging to cockroaches, but of which little more can be said. Fig. 11 comes from Cossett's pit No. 1, at Sydney, Cape Breton, and was found by Col. A. J. Hill; it has no natural border whatever, and may belong to almost any part of the wing; it may perhaps be a portion of an externomedian area, similar to that of *Petrabl. sepulta* (with which it was found), and in that case would probably represent a distinct species. Lower carboniferous.

Fig. 13 probably represents the central portion of a wing, the right hand set of branches belonging to the scapular, the left hand set, which are wrongly represented as connected at base with those of the right hand, then belonging to the externomedian vein. The specimen (No. 2010) came from immediately below vein C at Cannelton, Beaver Co., Penn., and was discovered by Mr. I. F. Mansfield, through whom I received it. It represents a species of perhaps the same size as *Archim. parallelum*, and possibly belongs to it; but as no part of the margin is preserved, any attempt to place it is useless. Lower coal measures of Pennsylvania.

Polyzosterites.

Polyzosterites Gold., Vorw. Faun. Saarb., 18; — Ib., Faun. saraep. foss., i, 18.

Goldenberg defines the genus as consisting of cockroaches in which both sexes are apterous, with nearly semicircular, very slightly marginate pronotum, and a flat, crustacean-like abdomen with sharply edged margin.

Polyzosterites granosus.

Adelophthalmus (*Eurypterus*) *granosus* Meyer, Palaeontogr., IV, 8–12, pl. 2, figs. 1, 2.
Eurypterus granosus Salt.-Woodw., Chart foss. Crust., pl. 3, fig. 15.
Polyzosterites granosus Gold., Vorw. Faun. Saarbr., 18; — Ib., Faun. saraep. foss., i, 18, pl. 1, fig. 17; — Ib., Faun. saraep. foss., ii, 20, 51.

Goldenberg describes the species as follows: —

"The pronotum, beneath which, as usually, the head lies concealed, is semi-elliptical, narrowed and rounded anteriorly; its greatest breadth, which falls near the posterior blunt angles, is scarcely less than 28 mm.; the length does not appear to have exceeded 16 mm. The convexity is gentle, and the slightly concave posterior border is accompanied by a feeble margin. The next two thoracic segments have in general a shape similar to that of the succeeding segments of the abdomen. All of them are tumid, not only laterally, but also in front and behind, and bordered with a slender marginal piece, connecting each segment with the preceding. The abdominal and thoracic segments together form a regular oval; the pointed, lobe-shaped outer extremities of the segments become gradually larger and broader toward the extremity of the body, as in living species of Polyzosteria; the last four rings are not so well preserved as the others, and are thrown far out of position, so that the last ventral segment is turned completely around. The thoracic as well as the abdominal segments have the dorsal surface covered with small, crowded tubercles, which are most prominent on the more tumid portions, and by the unaided eye can be seen to be of a blunt, triangular form, directed backward. An entirely similar structure may be seen in what appears to be *Polyzosteria limbata* Burm. Had such an animal been found fossil, it would very likely have been taken for a blind Eurypterus, were it not for the form of the extremity of the abdomen, which in all Eurypteri is linear or linear-lancet shaped."

"This fossil was found in the Eisenbahnschacht near Jägersfreude, in an ironstone nodule. Near Altenwald I found also in such a nodule a similar fossil, but not so completely preserved, which may probably have belonged to another and smaller species of this genus."

Goldenberg figures an articulated fragment found beside the abdomen, and which Meyer, considering the animal as a Eurypterus, had compared to the maxillipeds or false abdominal feet of the modern genus Serolis, but which Goldenberg takes for a Myriopod, like Polyxenus. So far as his illustration goes, it might be taken for the antennae of the insect itself. The form of the last segment indicates a female.

Postscript. November, 1879.—It will not fail of notice how opposed to the drift of this entire essay is the statement of Gerstaecker (Bronn's Klassen und Ordnungen des Thierreichs, v, 292) that the cockroaches described by Germar and Goldenberg from Wettin and Saarbrücken agree in every distinctive family characteristic with those now living ("*stimmen in allen für die betreffenden Familien charakteristischen Merkmalen mit denjenigen der Jetztzeit überein*"). In the same place (p. 291) Gerstaecker remarks that scarcely a single extinct form of cockroach approaches in size the largest living species of the family. Yet, as I have stated, the average size of ancient types may be considered somewhat larger than in modern times.

Gerstaecker (loc. cit. 292, note) considers the wing described by Dohrn under the name of *Fulgora Ebersi* as the nind wing of a cockroach, with most of the anal field destroyed.

It does not, however, agree at all with the structure of the hind wings of palæozoic cockroaches already known.

Only after the printing of most of this paper have we had access to a paper by Dr. C. J. Andrä (Eine Alge und eine Insectenflügel aus den Steinkohlenformation Belgiens. < Sitzungsb. niederrhein. Gesellsch. Bonn, 1876, 27–28) in which mention is made of the occurrence of the wing of a cockroach in the coal formation of Belgium. The author merely states that an elliptical fragment, representing the margin of a wing, was found, the distribution of the veins in which substantially agreed with that of "Blattina."

Explanation of the Plates.

PLATE II.

All the figures on this plate and the two following are camera lucida copies from other authors; the scale is altered where necessary, so as to be uniformly about two diameters above the natural size; the marks outside the wing represent the limits of the several areas. They all represent European insects. Drawn by the author.

Fig. 1. *Etoblattina anthracophila* (Germ.), p. 84. Copied from Münster's Beiträge zur Petrefactenkunde, v, pl. 13, fig. 3; reversed and the border restored.

Fig. 2. *Etoblattina affinis* (Gold.), p. 82. Copied from the Neues Jahrbuch für Mineralogie, 1869, pl. 3, fig. 3; reversed.

Fig. 3. *Etoblattina carbonaria* (Germ.), p. 93. Copied from Germar's Versteinerungen des Steinkohlengebirges von Wettin, etc., pl. 31, fig. 6^b; reversed, and the apical margin restored. The scapular area, however, is represented as broader than it should be, and the restored outline is probably too contracted.

Fig. 4. *Etoblattina flabellata* (Germ.), p. 82. Copied from Münster's Beiträge zur Petrefactenkunde, v, pl. 13, fig. 4^b; reversed, and the border restored.

Fig. 5. *Etoblattina Dohrnii* Scudd., p. 86. Copied from the Neues Jahrbuch für Mineralogie, 1869, pl. 3, fig. 8, right wing; reversed. The outside mark, representing the termination of the anal area, should be carried one interspace further toward the tip of the wing.

Fig. 6. *Etoblattina russoma* (Gold.), p. 96. Copied from the Neues Jahrbuch für Mineralogie, 1869, pl. 3, fig. 2^a; reversed.

Fig. 7. *Etoblattina? insignis* (Gold.), p. 102. Copied from part of an original drawing received from Dr. Goldenberg, from which pl. 2, fig. 14^a of his Fauna saraepontana fossilis, i, was taken. The restored tip is inaccurately represented as fully rounded, whereas it should closely resemble the apex of fig. 9. Cf. pl. 4, fig. 9.

Fig. 8. *Anthracoblattina spectabilis* (Gold.), p. 108. Copied from the Neues Jahrbuch für Mineralogie, 1868, pl. 3, fig. 7; reversed.

Fig. 9. *Etoblattina parvula* (Gold.), p. 101. Copied from the Neues Jahrbuch für Mineralogie, 1869, pl. 3, fig. 6.

Fig. 10. *Etoblattina elongata* Scudd., p. 100. Copied from the Neues Jahrbuch für Mineralogie, 1875, pl. 1, fig. 2; reversed, and with the basal margins restored.

Fig. 11. *Gerablattina Geinitzi* (Gold.), p. 123. Copied from the Neues Jahrbuch für Mineralogie, 1868, pl. 3, fig. 5.

Fig. 12. *Gerablattina Münsterii* Scudd., p. 124. Copied from Germar's Versteinerungen des Steinkohlengebirges von Wettin, etc., pl. 31, fig. 5^b; the apical margin restored.

Fig. 13. *Etoblattina didyma* (Germ.), p. 95. Copied from Germar's Versteinerungen des Steinkohlengebirges von Wettin, etc., pl. 31, fig. 3; reversed.

Fig. 14. *Etoblattina manebachensis* (Gold.), p. 99. Copied from the Neues Jahrbuch für Mineralogie, 1869, pl. 3, fig. 4.

Fig. 15. *Etoblattina anaglyptica* (Germ.), p. 89. Copied from Germar's Versteinerungen des Steinkohlengebirges von Wettin, etc., pl. 31, fig. 4; reversed, and the apical margin restored. The basal curve of the main veins is not well represented.

Fig. 16. *Etoblattina euglyptica* (Germ.), p. 80. Copied from Germar's Versteinerungen des Steinkohlengebirges von Wettin, etc., pl. 31, fig. 8, with the apical margin restored. Cf. pl. 4, fig. 7.

PLATE III.

See preliminary explanations to Plate II.

Fig. 1. *Gerablattina weissiana* (Gold.), p. 129. Copied from the Neues Jahrbuch für Mineralogie, 1868, pl. 3, fig. 10; with part of the inner border restored. The outside mark, indicating the lower limit of the externomedian area is placed much too far from the tip of the wing; there should be also a single branch to the internomedian vein.

Fig. 2. *Gerablattina producta* Scudd., p. 126. Copied from the Neues Jahrbuch für Mineralogie, 1868, pl. 3, fig. 9; reversed.

Fig. 3. *Gerablattina scaberata* (Gold.), p. 122. Copied from Goldenberg's Fauna saraepontana fossilis, ii, pl. 1, fig 8; reversed. The branch of the externomedian vein, being conjectural, should have been dotted throughout.

Fig. 4. *Gerablattina clathrata* (Heer), p. 120. Copied from the Vierteljahrsschrift der naturforschenden Gesellschaft, Zürich, ix, pl., fig. 3; with the inner and apical margin restored. This figure accidentally represents the wing as magnified a little less than two diameters.

Fig. 5. *Etoblattina labachensis* (Gold.), p. 79. Copied from Goldenberg's Fauna saraepontana fossilis, i, pl. 2, fig. 15; reversed.

Fig. 6. *Gerablattina Germari* (Gieb.), p. 127. Copied from Germar's Versteinerungen des Steinkohlengebirges von Wettin, pl. 31, fig 9.

Fig. 7. *Etoblattina primaeva* (Gold.), p. 78. Copied from Palaeontographica, iv, pl. 3, fig. 4ª.

Fig. 8. *Etoblattina mantidioides* (Gold.), p. 92. Copied from the Geological Magazine, iv, pl. 17, fig. 6. The restored outline of the apical half of the wing is undoubtedly incorrect, and the inner margin of the base is represented as much too convex; a corrected figure will be found in the text, p. 93; the outside mark indicating the lower limit of the scapular area should be removed to the apex of the wing.

Fig. 9. *Etoblattina leptophlebica* (Gold.), p. 97. Copied from the Neues Jahrbuch für Mineralogie, 1869, pl. 3, fig. 1ª; reversed, and with the apical margin restored.

Fig. 10. *Progonoblattina helvetica* (Heer), p. 139. Copied from the Vierteljahrsschrift der naturforschenden Gesellschaft, Zürich, ix, pl., fig. 1.

Fig. 11. *Gerablattina intermedia* (Gold.), p. 121. Copied from Goldenberg's Fauna saraepontana fossilis, ii, pl. 1, fig. 10; reversed.

Fig. 12. *Progonoblattina Fritschii* (Heer), p. 140. Copied from the Vierteljahrsschrift der naturforschenden Gesellschaft, Zürich, ix, pl., fig. 2; with the apical margin restored.

Fig. 13. *Gerablattina Goldenbergi* (Mahr), p. 118. Copied from the Neues Jahrbuch für Mineralogie, 1870, p. 284, fig, 1; with the apical margin restored.

Fig. 14. *Gerablattina Mahri* (Gold.), p. 128. Copied from the Neues Jahrbuch für Mineralogie, 1870, p. 284, fig 2ª; with the basal and apical margins restored.

PLATE IV.

See preliminary explanations to Plate II.

Fig. 1. *Anthracoblattina Rückerti* (Gold.), p. 116. Copied from the Neues Jahrbuch für Mineralogie, 1868, pl. 3, fig. 11; with most of the border restored; probably this represents the wing as broader than it should be.

Fig. 2. *Anthracoblattina Remigii* (Dohrn), p. 115. Copied from Palaeontographica, xvi, pl. 8, fig. 3, with the inner and apical margins restored.

Fig. 3. *Blattina latinervis* Heer, p. 147. Copied from the Vierteljahrsschrift der naturforschenden Gesellschaft, Zürich, ix, pl., fig 4ª.

Fig. 4. *Petroblattina gracilis* (Gold.), p. 144. Copied from Palaeontographica, IV, pl. 3, fig. 3ᵃ; reversed. One of the middle anal veins is wrongly represented as forked.

Fig. 5. *Anthracoblattina porrecta* (Gein.), p. 113. Copied from the Neues Jahrbuch für Mineralogie, 1875, pl. 1, fig. 4.

Fig. 6. *Blattina venosa* Gold., p. 148. Copied from Goldenberg's Fauna saraepontana fossilis, ii, pl. 1, fig. 7.

Fig. 7. *Etoblattina euglyptica* (Germ.), p. 80. Copied from Germar's Versteinerungen des Steinkohlengebirges von Wettin, etc., pl. 31, fig. 7ᵇ (pars). Hind wing; cf. pl. 2, fig. 16.

Fig. 8. *Anthracoblattina sopita* Scudd., p. 109. Copied from the Neues Jahrbuch für Mineralogie, 1875, pl. 1, fig. 1, left wing.

Fig. 9. *Etoblattina? insignis* (Gold.), p. 102. Copied from part of an original drawing received from Dr. Goldenberg, from which pl. 2, fig. 14ᵃ of his Fauna saraepontana fossilis, i, was taken. Hind wing; cf. pl. 2, fig. 7.

Fig. 10. *Blattina Tischbeini* Gold., p. 147. Copied from Goldenberg's Fauna saraepontana fossilis, i, pl. 2, fig. 16ᵇ.

Fig. 11. *Hermatoblattina lebachensis* (Gold.), p. 137. Copied from Palaeontographica, IV, pl. 6, fig. 7; with the apical margin restored.

Fig. 12. *Anthracoblattina winteriana* (Gold.), p. 114. Copied from the Neues Jahrbuch für Mineralogie, 1870, p. 288, fig. 2; with the basal margins restored. The figure is probably too small; see p. 115.

Fig. 13. *Oryctoblattina reticulata* (Germ.), p. 142. Copied from Germar's Versteinerungen des Steinkohlengebirges von Wettin, etc., pl. 39, fig. 15ᵇ; with the apical margin restored.

Fig. 14. *Hermatoblattina wemmetsweileriensis* (Gold.), p. 135. Copied from Goldenberg's Fauna saraepontana fossilis, ii, pl. 1, fig. 9; reversed. The costal margin is a little too full.

PLATE V.

All the figures on this plate are original, and represent American insects. They were drawn on stone by L. Trouvelot.

Fig. 1. *Mylacris bretonense* (Scudd.), p. 61. Magn. ⅔; drawn by S. H. Scudder.

Fig. 2. *Lithomylacris angustum* Scudd., p. 68. Magn. ⅔; drawn by J. H. Emerton.

Fig. 3. *Lithomylacris angustum* Scudd., p. 68. Magn. 1; drawn by J. H. Emerton.

Fig. 4. *Lithomylacris pittstonianum* Scudd., p. 70. Magn. ⅔; drawn by J. H. Emerton.

Fig. 5. *Lithomylacris simplex* Scudd., p. 71. Magn. ⅔; drawn by S. H. Scudder.

Fig. 6. *Mylacris anthracophilum* Scudd., p. 65. Magn. ⅔; drawn by S. H. Scudder.

Fig. 7. *Mylacris anthracophilum* Scudd., p. 66. Magn. 1; drawn by J. H. Emerton. Pronotum.

Fig. 8. *Mylacris anthracophilum* Scudd., p. 65. Magn. 1; drawn by J. H. Emerton.

Fig. 9. *Necymylacris heros* Scudd., p. 74. Magn. ⅔; drawn by J. H. Emerton. The first (inferior) offshoot of the first scapular branch should be forked near the tip, or directly opposite the extremity of the first branch itself.

Fig. 10. *Lithomylacris pittstonianum* Scudd., p. 70. Magn. 1; drawn by J. H. Emerton.

Fig. 11. *Mylacris Heeri* (Scudd.), p. 63. Magn. ⅔; drawn by S. H. Scudder. The uppermost fork of the apical branch of the internomedian vein is not sufficiently longitudinal.

Fig. 12. *Necymylacris lacoanum* Scudd., p. 73. Magn. ⅔; drawn by J. H. Emerton.

Fig. 13. *Mylacris pennsylvanicum* Scudd., p. 64. Magn. 1; drawn by J. H. Emerton. See note to next figure.

Fig. 14. *Mylacris pennsylvanicum* Scudd., p. 64. Magn. ⅔; drawn by J. H. Emerton. The mediastinal branch next the humeral lobe should have been omitted from this and the preceding figure; it does not exist. The restored outline of the wing probably extends too far outward.

Fig. 15. *Mylacris Mansfieldi* Scudd., p. 67. Magn. ⅔; drawn by J. H. Emerton.

PLATE VI.

Excepting fig. 5, all the drawings on this plate are original, and represent American insects. They were placed on stone by L. Trouvelot.

Fig. 1. *Gerablattina fascigera* (Scudd.), p. 133. Magn. ⅔; drawn by J. H. Blake. The base of the

externomedian vein should have been represented as united at the base with the scapular vein; the outside mark indicating the end of the scapular area is placed slightly too high; that indicating the end of the anal area is placed on the wrong side of the anal furrow.

Fig. 2. *Gerablattina fascigera* (Scudd.), p. 133. Magn. 1; drawn by J. H. Blake.

Fig. 3. *Etoblattina Lesquereuxi* Scudd., p. 87. Magn. 1; drawn by J. H. Emerton. See note to next figure.

Fig. 4. *Etoblattina Lesquereuxi* Scudd., p. 87. Magn. 1; drawn by J. H. Emerton. One or two basal branches of the mediastinal vein are not shown. The origin of the middle externomedian branch is wrongly represented; see a corrected figure of the latter in the text, p. 88.

Fig. 5. *Etoblattina weissigensis* (Germ.), p. 85. Copied from the Neues Jahrbuch für Mineralogie, 1873, pl. 3, fig. 1; reversed. Camera lucida sketch by S. H. Scudder. This is a European species.

Fig. 6. *Archimylacris parallelum* Scudd., p. 105. Magn. 1; drawn by J. H. Emerton. The mediastinal vein of the front wing should be represented as gradually approaching the costal margin in the basal half of the wing. The mediastinal vein of the hind wing can be seen on the specimen, underlying the front wing, but is not represented on the plate. The wing is accompanied by the pronotum.

Fig. 7. *Petroblattina sepulta* (Scudd.), p. 145. Magn. 1; drawn by S. H. Scudder. The inner margin of the fragment is represented as more convex than it should be; the short line representing the main mediastinal line in the middle of the fragment should be nearly parallel to the margin, not oblique.

Fig. 8. *Archimylacris acadicum* Scudd., p. 104. Magn. 1; drawn by S. H. Scudder. The middle internomedian branches are given too sinuous a curve.

Fig. 9. *Gerablattina balteata* Scudd., p. 130. Magn. 1; drawn by J. H. Blake. The terminal part of the internomedian vein, as described in the text, is not shown here; the outside mark indicating the outer termination of the internomedian area should be considerably nearer the tip of the wing.

Fig. 10. *Gerablattina balteata* Scudd., p. 132. Magn. 1; drawn by L. Trouvelot. Represents the anal area only.

Fig. 11. Fragment of the wing of a cockroach from Sydney, Cape Breton; p. 148.

Fig. 12. *Etoblattina venusta* (Lesq.), p. 90. Magn. 1; drawn by J. H. Blake. The restored outline of the base of the wing very probably represents too much as lost.

Fig. 13. Fragment of the central portion of the wing of a cockroach from Cannelton, Penn.; p. 148.

Fig. 14. *Archimylacris acadicum* Scudd., p. 104. Magn. 1; drawn by S. H. Scudder.

The Devonian Insects of New Brunswick.

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I. Introduction.

INVESTIGATION of fossil remains of the oldest insects is nearly always extremely difficult and perplexing, and often very unsatisfactory in its results. The interest, however, necessarily attaching to the beginnings of life, warrants any labor that may be expended upon them. Especially is this true of the fragments treated of in this paper, because they are as yet the only insect remains which have been found in rocks older than the carboniferous formation in any part of the world. The writer may be pardoned for adding that they possess a special attraction for him, as among the specimens which first directed his particular attention to fossil insects, and he only regrets that so long a period as fifteen years should have elapsed before their full discussion.

The remains consist entirely of broken wings, and were discovered in 1862, by the late Professor C. F. Hartt (at the time of his death director of the geological survey of Brazil), while searching for plant remains in the devonian shales near St. John, New Brunswick. The locality — called Fern Ledges by Mr. Hartt, from the abundance of plant remains which occur in the black shales that are interstratified with the prevailing sandstones — is about a mile west of the town of Carleton, not far from St John. The rocks form a series of ledges, exposed on the sea-shore between high and low water marks. The beds of sandstone and shale, of which they are composed, have a seaward dip of about 45°, and a strike of about W. 10° N., corresponding very nearly to the trend of the shore. The fossiliferous shales between the enclosing sandstones are worn away by the action of the water, leaving the fossils accessible in only a few places. The whole deposit is of very limited extent; it reaches along the shore for about three hundred and twenty-five paces, exposing a thickness of strata of about forty-five meters, with a width of about ninety meters.

The specimens discovered were six in number, some of them with their reverses. They are now in the museums of the natural history societies of St. John, N. B. and Boston, Mass. I am much indebted to Mr. G. F. Matthew, of the former institution, and to Professor A. Hyatt of the latter, for the opportunity of studying these specimens anew at my leisure.

The plan of the present paper will be seen by a glance at the table above. As the simpler devonian insects, first described, have certain special relations with the Ephemeridae, their description is preceded by an account of the wing structure of the modern May-flies, as a basis of comparison; each of the devonian species is then separately described, and its affinities discussed, and the whole is followed by a general summary. The stratigraphical question being, in this instance, of special importance, Principal Dawson has kindly prepared for me a statement of the case with which the article closes.[1]

II. The Structure of the wings in Ephemeridae; with a note on a jurassic species.

The following statement considers mainly the direction and division of each of the principal veins, and the comparative areas covered by them.

The marginal vein forms the costal border. The mediastinal vein is absent or, perhaps, amalgamated with the scapular in Lachlania, Oligoneuria and Tricorythus; in all others it is simple, and extends to, or almost to, the tip of the wing, keeping at a very short and nearly uniform distance from the margin, with which it is generally connected, especially on the apical half of the wing, by frequent cross veins. On the basal half, the cross veins may be as abundant as apically, but they are generally rarer, and may be entirely absent, even when frequent apically; or they may be absent throughout. In very rare instances, as in Coloburus, an intercalary vein may be found in the apical half of the wing between this vein and the costal margin.

The scapular vein is simple, and reaches the tip of the wing, excepting in the three genera mentioned above, where it may perhaps be said to be amalgamated with the mediastinal, as shown by its forking near the middle of the wing in Tricorythus; in Lachlania, however, it terminates not at the tip, which possesses only the marginal vein, but near the middle of the costal border. It is always connected with the vein below by a greater or less number of, usually many, cross veins.

The externomedian vein is always compound, and always covers at least half, usually much the greater part of the wing. It always divides at the very base, and the upper branch is always forked, while the lower may, although rarely, remain single, and is usually forked to a less extent than the upper branch. Three is, therefore, the smallest number of nervules which may reach the margin in the area covered by

[1] Besides the references given in the bibliography under each species, notices of the devonian insects will be found in the following places: Hartt, on the Devonian plant-locality of the Fern Ledges, Lancaster, N. B., in Bailey's Observations on the Geology of Southern New Brunswick, pp. 131–40. 8vo., Fredericton, 1865; reprinted in substance, in Dawson's Acadian Geology, 2d ed., pp. 513–23. 8vo. London, 1868. Darwin, Descent of man, I, 360. 12mo. London, 1871. Stett. Ent. Zeit., XXVIII, 145–53, *passim*. Trans. Entom. Soc. Lond., 1871, 38–40. American Naturalist I, 445, 625–26. Proc. Boston Soc. Nat. Hist., X, 96, XI, 150–51. Memoirs Boston Soc. Nat. Hist. III, 13–21, *passim*.

the vein, and this number we find in Oligoneuria and, perhaps, in Lachlania. The portion of the area of this vein covered by the upper branch and its forks is almost always greater, generally considerably greater, than that covered by the lower branch; an exception to this will be found in Polymitarcys where the lower area is greater, owing to unusual breadth of wing combined with narrowness of the area covered by the intermedian vein, which has been crowded out of much of its natural ground by this lower branch. Some of the allies of Polymitarcys, especially Asthenopus and Pentagenia, also have this area of the lower branch larger than usual, although not larger than that of the upper branch, and some other genera not placed near it exhibit a similar propensity; but as a general thing, the area covered by the lower is scarcely more than half as large as that covered by the upper branch, and not infrequently it is less than one third its extent. The upper branch usually forks close to the base, occasionally at the very base, and sometimes the upper of the forks is amalgamated at the base with the scapular vein, as in Asthenopus, Tricorythus and Chloeon, and to a certain extent in Coenis, so as to give it the appearance of originating from that vein, and of complete independence of the externomedian; whether thus severed from its connections, or plainly arising from the externomedian root, this upper fork of the upper branch runs in proximity to the scapular vein, parallel or subparallel to it, and, excepting where the venation is occasionally simple (as in Oligoneuria, &c.), always emits from its lower surface in the central portion of the wing one, two, or three nervules; the first and second of these nervules are usually pretty near together at base, but all generally reach the border at unequal distances apart, the inequality being made good by intercalary longitudinal nervules; these intercalary nervules often curve at their inner extremities toward or to one or another of the adjoining nervules, assuming then the appearance of regular branches, while the nervules proper are themselves oftener detached from their base; so that it is sometimes difficult to tell whether a given vein should be considered normal or intercalary. The lower fork of the upper branch is occasionally simple, as in the Tricorythus, but usually forks once at about the middle of its course, rarely near the base, and very frequently encloses an intercalary nervule between these branches, but no intercalary nervules (excepting such as often break up the extreme margin into an irregular meshwork of veins) ever intervene between the upper nervule of this fork and the lower nervule of the upper fork, nor between its lower nervule and the upper nervule of the lower branch of the externomedian vein, excepting in the rare instances where this lower nervule is detached from its base, and takes on the form of an intercalary nervule.

This lower branch, as has been said, is usually forked to a less extent than the upper branch, but a conspicuous exception is found in Polymitarcys where the branch is made up of a large number of sub-convergent simple rays, directed from the outer margin toward various parts of the upper internomedian nervule, but generally lost before reaching it. In general, however, its area is only about half that of the upper branch; it usually forks close to the base, and each or either of its branches may again subdivide once; all other nervules in the area are sure to be intercalary; where it forks only once there is usually a single intercalary nervure midway between the branches, which seems to belong to one or the other of them and to represent its fork; while between it and either branch there

may be other shorter intercalaries; the only exception to this general statement is the case of Polymitarcys already cited, where after division at the base the upper fork must be looked upon as breaking up at once into three rays, while the lower severed from its connections breaks up similarly into a couple of forked rays; the amount of abnormal divergence in this case may be better seen, by stating that it is the only genus of Ephemeridæ in which this area is carried around the lower outer angle of the wing; in all others it stops short of, usually far short of this angle; here it reaches around it half way along the anal margin. The genus agrees, however, with all the others in that all the branching occurs in the basal half of the area. In Oligoneuria and Lachlania the branch is simple and undivided, unless the apparent branch in the latter should be looked upon as such, and not as a cross nervure, like the more directly transverse veins above it.

The area of the internomedian vein is never great, although always more extensive than that of any other vein but the externomedian, and it always includes the lower outer angle of the wing, excepting as above specified in Polymitarcys, and excepting also in the full-angled Tricorythus, where the anal area disputes its sway. Its construction is generally similar to that of the lower branch of the extermomedian vein, although from the form of the area covered by it, its absolute appearance is very different; moreover, one rarely finds in it any intercalary nervures, excepting such as sometimes line the extreme border, the smaller nervures almost always originating from the main stems; the exceptions are found in Leptophlebia, Cloeon, and Baetis. The vein almost invariably forks at its extreme base, and from the upper of these branches sends either, rarely, a single shoot, or, much more frequently, a half a dozen, occasionally a dozen simple or forked shoots to the margin. In the interesting fossil described in the note at the end of this section these shoots appear to originate from the lower branch, the upper remaining simple, just as rarely occurs in living forms as *e. g.*, in some species of Leptophlebia.

The anal vein invariably plays an insignificant part, and is apparently sometimes wanting. Its area seldom reaches even half way along the anal margin, but in Tricorythus it extends even round the lower outer angle, fairly upon the outer margin. Here it is composed of a single vein with three or four short but widely divergent branches; usually it is forked at the base, and occasionally one or the other of these forks imitates the rayed branch of the internomedian, by sending a number of parallel branches, often closely crowded, to the margin.

This account of the neuration of the Ephemeridae is based upon much more extended material, and a longer study than that formerly given by me in my first quarto paper on fossil neuroptera, and corrects it in several important particulars, especially in the account of the internomedian vein, which was erroneously stated to be simple [1] and in the fuller statement of the divisions of the externomedian vein.

Note on a Jurassic May-fly.

Hexagenites Weyenberghii, gen. et sp. nov.:—A fragment of a wing only is preserved, in which the entire costal area and base are wanting. The neuration of the parts that remain

[1] This statement was evidently the result of some oversight, since in the digest given on a subsequent page of the same memoir it was remarked that the internomedian vein was "similar in character to the *vena externomedia*."

is perfect and indicate an insect whose alar expanse was nearly 45 mm., and which is most nearly related to Hexagenia; the first inferior nervule of the upper fork of the upper branch of the externomedian vein is thrown off some way before the middle of the wing; the lower branch forks at some distance beyond the middle of its course, and encloses between its branches a single intercalary nervule which extends nearly to the widely spreading fork. At a short distance from the base of the wing the lower branch of the externomedian vein has divided into three branches, the middle one nearer the upper than the lower, all of which continue undivided to the margin; two intercalary nervures of unequal length occur in each of these interspaces, extending almost half way to the base in the lower interspace, besides many short ones near the margin; the lowest of these branches is considerably curved and subparallel to the inner margin. The internomedian vein probably divides at the very base into two branches, the upper of which is simple, runs subparallel to the lowest externomedian nervule, striking the angle of the wing, while the other branch is in close proximity to it and throws off a large number of sinuous simple branches to the anal margin, in doing which its outer half follows an irregular course by a slight change of direction with each emission. The cross veins are moderately frequent and subuniform throughout the portion of the wing which is preserved excepting in the internomedian area, and the border is much broken by intercalary nervules into cells which are quadrate and generally much longer than broad. The anal area must be very contracted and the form of the wing closely resembles that of Hexagenia.

The specimen is from Solenhofen, and is in the British Museum. The description is drawn up from a very clear sketch magnified 7 diameters, taken with the camera and published by Rev. Mr. Eaton in the Transactions of the Entomological Society of London, 1871. Pl. 1, fig. 10. The species is dedicated to my friend Dr. Weyenbergh, of Cordoba, who has done so much in increasing our knowledge of the Jurassic insect fauna of Bavaria.

III. Platephemera antiqua. Pl. 7, figs. 5, 9, 10.

Platephemera antiqua Scudd., Can. nat., (n. s.) iii, 205, fig. 2 (1867);—Ib., Geol. mag., iv, 387, pl. 17, fig. 2 (1867); — Ib., Dawson, Acad. Geol., 2d ed., 524, fig. 181 (1868); — Ib., Amer. nat., i, 630, pl. 16, fig. 3 (1868); — Ib., Geol. mag., v, 173, 175–76 (1868); — Pack., Guide ins., 77–78, pl. 1, fig. 3 (1869); — Nichols., Man. pal., 185, fig. 128 (1872); — Ib., Anc. life hist. earth, 145, fig. 89 (1877); — Dana, Man. geol., 2d ed., 273, fig. 550 A (1874); — Roem., Leth. geogn., pl. 31, fig. 9 (1876).

Mentioned without name, as the first species, in my letter to Mr. Hartt on the Devonian Insects of New Brunswick (1865); — Bailey, Obs. geol. south. New Brunsw., 140 (1865); Amer. journ. sc., (2) xxxix, 357 (1865); — Can. nat., (n. s.) ii, 23 (1865); — Trans. entom. soc. Lond., (3) ii, 117 (1865). See also Amer. journ. sc., (2) xl, 277 (1865).

The wing was ample (whence the generic name) and gigantic. Probably a third of the wing is wanting at the base, besides the greater part of the extreme outer edge, but the fragment preserved enables us to to judge, probably with considerable accuracy, both the general structure and, by the direction of the nervules and of the margins, the general

form of the wing, which is presumed to be much as outlined on the plate. The wing was probably more than 60 mm. in length, and about 27 mm. in breadth; the alar expanse was therefore at least 125 mm., and probably 135 mm., and the two figures have been so placed as to indicate this expanse.

This is more than double the ordinary size of the larger Ephemeridae and the largest mentioned in Eaton's paper on these insects has an expanse of only 78 mm., and the largest of the jurassic species only 65 mm.

The costal margin is very gently arcuate; the apex probably somewhat pointed, toward which the upper veins are directed without additional arcuation; the greatest breadth was probably a little before the middle of the wing, and the outer perhaps half as long again as the anal margin. The marginal vein runs close to but does not form the margin of the wing, the latter being indicated in the figures on the plate by a dotted line.

The mediastinal vein runs as close as possible to the margin, and is not connected with it by cross veins; these two veins apparently run side by side to the apex, when the marginal disappears and the mediastinal takes its place close to the border. The scapular vein runs sub-parallel to the mediastinal, but at double the distance from it apically as basally, the change occurring rather abruptly near the middle of the preserved portion of the wing; it is connected with the vein above by straight cross-veins at tolerably regular, rather frequent intervals.

As usual in this family, the externomedian vein is apparently divided, probably not far from, or at the base, into two stems, and the upper of these stems is again divided, probably at some distance from the base, into two principal branches; the main portion of the upper branch runs parallel to, but somewhat distant from the scapular vein, approaching it, however, apically, and is everywhere connected with it by cross-veins, very much as in the mediastino-scapular interspace; it throws off from its inferior surface several inequidistant feeble offshoots; the first originate a little before the middle of the wing, and run irregularly but with a gentle downward curve to the outer margin; they have between them and between the outermost and the main branch a number of equally irregular intercalary nervules, all of which are connected together by cross-veins, and thus form over the whole area a mesh work of irregular but usually hexagonal and longitudinally elongated cells, making it impossible to distinguish between normal and intercalary veins, since the latter are as prominent as the former, and invariably arise from cross-veins; while whatever nervules lie next the main branch are united with it by frequent and, equally irregular cross-veins falling from the main branch quite in the manner of the offshoots proper, and forming cells only slightly larger than the others, although generally transversely elongated; together there are about nine rows of cells between the main upper branch and its first offshoot. The lower branch of the upper stem is simple and, originating apparently near the middle of the basal half of the wing, diverges at first slightly from the upper branch, afterwards a little more rapidly, and in its apical fourth curves downward considerably, and is somewhat irregular in its course; its direction is in general parallel to the offshoots, and especially the nearer offshoots of the upper branch, and on the border it is separated from the apex of the upper branch by nearly one-third of the outer margin of the wing; in its simplicity this branch resembles the same nervure in Tricorythus, which is peculiar in this particular among modern Ephemeridae. As in

modern Ephemeridæ generally, there is no intercalary nervule between this lower branch of the upper externomedian stem and the first offshoot of the lower branch, but this interspace is filled with simple and frequent cross veins.

The lower externomedian stem is apparently formed on the same plan as the upper, a feature which appears to have no counterpart among living Ephemeridae; apparently it is composed, like the upper, of two primary branches, which seem to part from each other very nearly at the same considerable distance from the base, (about one-third the distance to the margin), a feature uncommon but not unknown in living Ephemeridae; but instead of having a single independent intercalary or two between the forks, it has several offshoots which depend from the upper branch, just as the offshoots of the upper branch of the upper stem do, while between them in the outer half of their course other intercalaries arise, depending from angular cross veins — the whole united by frequent cross veins (again as in the upper area), to form a mesh-work of irregular cells generally pentagonal, although not often longitudinal; there are thus included between these forks about six rows of cells. The interspaces directly adjoining either side of the lower branch of the upper externomedian stem are slightly wider than the interspaces between the nervules in the area of the lower externomedian stem, possess no intercalaries, and are divided by frequent cross veins. The lower branch of the lower externomedian stem also curves downward at the tip, like the lower branch of the upper stem; the area of the lower externomedian stem repeats, therefore, and on only a little smaller scale, the structure of the area of the upper stem, instead of exhibiting, as in recent forms, distinctive features.

That portion of the fragment of the wing lying below what we have here considered the lower simple branch of the lower externomedian stem, and which is shown in fig. 10 and not in fig. 9, is so fragmentary and so separated from its basal connections that it is difficult to decide to what area of the wing it belongs; it consists of four rows of cells separated by curving nervules a little more uniform in their course than the minor nervules above, with slightly less frequent cross veins; the cells being slightly larger and more regular, frequently quadrangular and usually longitudinal; this field belongs of course either to the externomedian or the internomedian area. The general similarity of the structure of the fields would lead one at first to suppose it to belong to the externomedian area, in which case of course our description of the lower stem and its branches should be modified to receive it. As, too, the form of the fragment would indicate that a very considerable part of the region about the anal angle is lost, the reference of this field to the internomedian area would give that area a very great and very unusual preponderance in the wing. But its reference to the externomedian area, which is certainly possible, would involve quite as great an anomaly; for in that case the lower externomedian stem must be supposed to consist of two branches, the lower lying beyond the present fragment and probably simple, the upper forked and reproducing on a smaller scale the whole of the upper externomedian stem, including the minor offshoots depending from the uppermost branch of each. In this case the area of the lower stem would exceed that of the upper, which occurs in very rare instances in modern Ephemeridae and then only by crowding out of room the lower areas, which the probable wide expanse of this wing would not allow unless this lower area is of an exceedingly disproportionate size. The translation of the facts which I have offered in my description, on the other hand, while it

requires a very unusual development of the internomedian area, leaves the lower externomedian field in its usual proportionate extent as compared to the upper field, and is further supported by several considerations: chiefly by the probability that where repetitions of structure are found — a mark of simplicity much more common among ancient than among recent insects — they are far more apt to occur between repetitive parts than between those which may not be so exactly compared. On the hypothesis sustained above, this repetition occurs in the fields embraced between the two similarly disposed sets of branches into which one vein is divided. On the other suggested (and apparently the only alternative, for the open interspaces on either side of the lower branch of the upper externomedian stem seem to fix that nervule unquestionably) the repetition would be between the whole of one set of branches of this vein, and one portion only of the two of which the other set of that vein is composed. Other arguments may be advanced from the character both of the nervules and of the cells formed by them and the cross veins, which differ slightly from those in the field next above, a difference greater both in extent and in nature than that existing between what we have considered the upper and the lower externomedian fields. Further than this, the slight change of direction in the course of the outer margin, resulting in a slight emargination of this border of the wing, although apparently not found at all in living Ephemeridae, would be far more likely to occur, does far more frequently occur in other insects, between two adjoining areas than in the middle or other part of one.

Considering then the field under discussion as belonging to the internomedian area, we must describe this as plainly of very unusual extent, and as filled as it never is in living types with a large number of intercalary nervules.

It may be remarked that none of the many intercalaries in this wing arise independently, and that they are not more abundant at the extreme outer edge of the wing, as is frequently the case in modern types. The former feature is the more noteworthy, as the independent origin of the intercalary veins in Ephemeridae would naturally be taken as a mark of inferior organization; and yet it does not occur in this oldest member of the group, nor yet in the jurassic species from Solenhofen, described on a previous page; in this last, however, the edge of the wing is more broken by intercalaries than the parts removed from it.

The length of the fragment preserved is 42 mm. and its greatest breadth, 25.5 mm.

The points in which this insect presents the most striking differences from modern types, and upon which we would establish the genus Platephemera, are: the very similar instead of distinctive structure of the framework of the two sets of branches of the externomedian vein, and of the respective areas included between them; the excessive number of the intercalaries in the area included between the lower set of externomedian branches, and their attachment (in the apical half of the wing) to the upper of these branches — from which the previously mentioned peculiar feature mainly depends; the simplicity of the lower branch of the upper externomedian stem in an unusually ramose wing; the unusual extent of the internomedian area and its rich supply of intercalaries; the density and polygonal form of the cells formed by the cross veins below the upper externomedian vein; the emargination of the outer border; and finally the vast dimensions of the wing.

If we look to other early types for species akin to this we shall find a whole group of carboniferous insects with reticulated wings, to which this is evidently related. To this belong those forms to which the generic names Dictyoneura and Breyeria have been given in the old world, and Paolia and Haplophlebium in the new. Several new forms, as yet unpublished, are known to me from the American carboniferous rocks. In all these genera, but especially in Dictyoneura and Haplophlebium (which perhaps should not be separated from each other), the wing is very much larger and slenderer (like a dragon-fly's wing) than the fragment of this devonian wing will allow us to suppose it to be. As in these wings, the mediastinal vein is present, and usually runs into the marginal at some distance from the tip of the wing, and the general relation of the principal veins is similar in all; in none of the others, however, do we find so distinct a meshwork of subordinate veins, nor can they be resolved as here into sets depending from the two principal branches of the externomedian vein. So that while a general similarity of structure may be conceded, there is no occasion for considering the insects as closely affiliated.

The distinction between Platephemera and Gerephemera will be pointed out in treating of the latter insect.

This insect comes from plant-bed No. 7 of Professor Hartt, and was the only insect found at that horizon.

In his "Monograph on the Ephemeridae,"[1] Rev. Mr. Eaton treats of the fossil species which have been referred by one and another author to this family, in a very summary manner,[2] asserting that: "when a fossil comprises only a fragment, or even a complete wing of an Ephemerid, it is hardly possible to determine the *genus*, and impossible to assert the *species*. The utmost that can be learned from such a specimen is the approximate relations of the insect. Neuration by itself is not sufficient to define the species or even the genera of recent Ephemeridae."

While we should not wish to deny the claims of Mr. Eaton to a profound knowledge of the structure of the Ephemeridae, we venture to doubt if he would assert that there are not features in the wing structure of some genera not found in others, and which are, therefore, in so far characteristic of those genera; and it might be worth while to consider whether a careful study of such differences would not reveal some further differences not discernible upon a cursory examination. One should be slow to hazard sweeping statements of a negative character; and after all, it may be enquired, what more is desired, or at least expected, than "the approximate relations of an insect" found fossil in the older rocks. That is precisely the aim of palaeontology the world over; and those who discourage efforts to discover these relations are simply bidding us close one of the volumes of the book of life, quite as valuable as that they study.

In further comments in the same place, Mr. Eaton asserts of the insects of the Devonian discussed in this paper, that "they have all been regarded as allies of the Ephemer-

[1] Trans. Entom. Soc. Lond., 1871, 38–40.

[2] The manner in which Mr. Eaton has confounded names in this section of his work is pretty fair evidence that he has not given the papers he quotes that close attention which would entitle him to use the language of ridicule toward their authors. In the three pages he devotes to this topic, Dyscritus is twice given as "Dyscritius"; articulatus twice as "antiquorum"; occidentalis once as "Brownsoni"; Bronsoni twice as "Brownsoni"; Dana twice as "Scudder"; Scudder six times as "Dawson."

idae." I do not know by whom; certainly not by myself, who first described them. Platephemera he says, may possibly belong to the Ephemeridae, "but there is nothing in the figures to make this certain." The better figures published with this should be sufficient proof that Platephemera belongs where I originally placed it. The neuration agrees in all essential features with that family, and indeed, considering the antiquity of the creature, shows marvellously little divergence from existing types. And although Mr. Eaton has nothing to say of the wing structure of the Ephemeridae as a whole, in distinction from that of other neuropterous families, I can hardly believe that any one who has studied it from the standpoint of the substantial unity of wing structure in all insects, could fail to discover that the Ephemeridae have a special development of wing neuration distinct from all others, permitting formulation, and to which Platephemera conforms to so close an extent, that until we have further light by the discovery of more complete remains we are amply justified in considering it as an antique type of Ephemeridae.

IV. Gerephemera simplex. Pl. 7, figs. 8, 8a.

Gerephemera simplex Scudd., Geol. mag., v, 174–75 (1868).

Mentioned without name, as the fourth species, in my letter to Mr. Hartt: On the devonian insects of New Brunswick, p. 1; Bailey, Obs. geol. south. New Br., 140; Amer. journ. sc., (2) xxxix, 357; Can. nat., (n. s.) ii, 235; Trans. Ent. Soc. Lond., (3) ii, 117—all in 1865.

In the specimen and reverse as first seen by me, scarcely more could be said of this insect than the brief notice already published; nothing appeared but a slight fragment of the tip of a wing, and this would not have been dignified by a name had not the extreme interest attaching to fossil insects from the horizon at which it occurred seemed to demand it. The portion preserved was the upper half of the outer border with the extremities of the veins impinging upon it, and two of the principal veins near the tip of the costal margin; these two veins are as usual in the Ephemeridae and probably represent the marginal and mediastinal (or scapular), and show that the latter reached the border scarcely above the tip of the wing.

Since my first examination, however, Mr. G. F. Matthew has worked out a considerable part of the wing on one of the stones belonging to the St. John Society, which, though very different in certain parts from what would have been anticipated from the portion first exposed, bears out in a measure the statement that was hazarded concerning it, although it proves that the generic name chosen was unfortunate. In this removal of the stone from the surface of the wing, a fragment of the tip with its two veins was flaked off; but as careful drawings had been taken of it, I have replaced the two lines indicating the veins mentioned above upon the drawing made of the wing as it now appears. This gives us indeed a much better clue to the probable form of the wing than we could possibly otherwise have, for the considerable and constantly increasing divergence of the upper and lower veins of the continuous portion of the fragment leave a very strange effect; and, without the aid these two vein-tips furnish, leave the form of the apex of the wing decidedly problematical.

The wing is that of a very large insect, the fragment, which reaches neither base nor tip, being 60 mm. long, and rendering it probable that the alar expanse was at least 150 mm. and more probably 175 mm. The apex of the wing was pointed, the costal and outer margin probably meeting at a rounded angle of about 60°. The costal margin must have been very strongly arched near the middle of the apical half, while the apical part of the outer border is nearly straight. The wing was probably elongated, not very broadly expanded in proportion to its length, as I at first presumed from not having counted on such an extended development toward the base. In the middle of the outer half of the wing the width is about 23 mm., and from the course of the fragments of the two borders it is probable that the width nowhere exceeded 25 mm. or about two-sevenths the length of the wing. The fragment preserved contains considerably less than half the area of the wing comprising most of the central portions. The whole anal area is lost as well as what is apparently most or all of the internomedian area, extending far along the outer margin; the merest fragment of the costal border, 2–3 mm. long, is preserved, apparently about the middle of the wing; the tip of the wing and outer half of the costal margin are broken away, but a couple of veins at the tip are supplied, as already stated, from a piece that was accidentally removed. This irregular fragment, extending diagonally across the outer half of the wing, with a basal extension along the middle line, is traversed by principal nervures bound together by a net work of mostly very irregular and very feeble, occasionally more regular and distinct cross veins, forming irregular, mostly longitudinal, unequal, polygonal, rarely quadrangular cells. The veins may be grouped into an upper set of parallel, equidistant and rather approximate, nearly straight, slightly upcurved nervures, three or four in number, traceable only near the middle of the wing; and a lower set of two, traceable throughout the apical half of the wing and extending nearly half way from the middle to the base; these are parallel, more distant, directed gently downward and so divergent from the other set, and toward the apex curved considerably downward Between the veins of the upper set the cross veins are infrequent and mostly straight, forming quadrangular cells; while in the lower set they are more frequent and very irregular, forming polygonal cells which, toward the apical margin, are very indistinct from the feebleness of the cross veins.

The area formed at the apex of the wings by the divergence of the two sets of veins, is filled by branches from the *superior* surface of the uppermost of the lower set of veins, supporting a mesh of cross-veins.

The principal vein of the wing then—the only one which appears unquestionably to support a number of branches — is the uppermost vein of the lower set. And since in all palaeozoic insects having true net-veined wings, one never has to pass beyond the externomedian vein, in starting from the costal margin, to find the first extensively branched vein, there can be little if any doubt that this should be considered as belonging to that vein, and not to a lower one. The only difficulty about this interpretation is that in the middle of the wing, there are above this vein no less than five equidistant and almost equally distinct veins. The first of these, forming the margin, is the marginal vein, and the next is the mediastinal. It is impossible to consider this marginal as the mere thickening of the border, and the vein next removed from the border as the true marginal vein, for both the margin itself would be too broad, and the marginal would

then be an elevated, and the mediastinal a depressed vein (see fig. 8a), which is never the case in such insects. The nervure at the margin then is certainly the marginal, and that next to it the mediastinal vein. Only one vein, the scapular, can lie between the mediastinal and the externomedian, yet between our undoubted mediastinal and our presumed externomedian there are no less than three veins to be disposed of.

Two of these lie in the depression following the mediastinal vein, while the third is upon the side or the upper edge of the ascending portion of the area, which on the opposite side of the depression lies at the level or above the level of the mediastinal vein (see fig. 8a). It seems, therefore, highly probable that the two low-lying veins are branches of a scapular vein which probably divides not much further toward the base; and that the third vein in question is the main externomedian stem, of which the branching vein below is only a principal basal offshoot; indeed the very fact that the branches of this offshoot are thrown off from its *superior* surface leads to the presumption that it is itself a branch from a vein above; for, while an area between two branches of one vein may not very infrequently be filled by superior offshoots from an inferior branch, it would certainly be abnormal for a wide area to be filled by superior offshoots from an upper branch, or even from a main stem itself. Presuming then upon the correctness of these interpretations, the structural basis of the wing is as follows:

The marginal vein forms the border. The mediastinal vein is simple, and, running nearly parallel to the marginal vein, probably terminates by impinging upon it not very far from the middle of the outer half of the wing; from it run frequent oblique delicate cross veins to the border. The scapular vein divides into two longitudinal veins before the middle of the wing, probably considerably before it; for even before the middle of the wing, and for as great a distance beyond it as it can be traced, the two branches are exactly parallel to each other and the mediastinal; all the longitudinal interspaces in the middle of this part of the wing are equal; the forks are connected with each other (and the upper with the mediastinal?) by tolerably frequent faint cross veins at right angles to the nervures; and in the middle of the wing and beyond it, at least for a short distance, have a gentle upward direction, and even curve very slightly, almost imperceptibly, in the same direction; beyond however, they must curve strongly in the opposite direction, for the pair of detached veins toward the tip of the wing have a decided downward direction, and these forks, whether the same or not, must in that part of the wing have a similar direction; probably they are the same, and if so they show that they retain a similar distance apart until they strike the costal margin, one just before or at the tip, the other a little earlier.

The externomedian vein must divide into two principal veins near the base of the wing; the upper branch follows closely the course of the veins above, and lies as far from the nearest as the latter from the next; a little beyond the middle of the wing, however, this space is slightly increased, and an intercalary vein, straight and similar to the others, but fainter, takes its rise from an oblique bent cross vein; all the other cross veins in this interspace and on either side of the intercalary vein, are like the others in the scapular interspaces, and the whole area in which these straight and directly transverse cross veins lie, namely that between the mediastinal and upper externomedian veins, forms a deeply sunken but broad sulcus, the floor of which is nearly flat, and not V-shaped as usual in folds in this

part of the wing; probably it is otherwise further toward the base of the wing before the division of the scapular vein, for the sides of the sulcus are tolerably steep, and where only a simple vein occupied the sulcus, as is ordinarily the case in neuropterous wings, the sulcus would be angular. The lower externomedian branch at the middle of the wing is already as far from the upper branch as that from the upper scapular branch, and continues to diverge from it with a very gentle curve, which increases apically, so that it strikes the border with the same direction as the veins above; in the interspace between these two branches runs a feeble intercalary vein, slightly irregular in direction, sending off cross veins to one side and the other, forming longitudinal irregularly pentagonal cells; as the interspace widens these become more irregular, until at about two-thirds the distance from the base of the wing to the tip of this branch, a superior offshoot from this branch is emitted, having a course about midway between the two branches, but very soon taking a somewhat zigzag direction, and assuming altogether the appearance of the intercalary, to which it sends frequent cross veins; a short distance further on, or at about the end of the second third of the wing, this emits a second offshoot, rather more prominent and regular than the first, which parts rapidly from the branch, and, remaining near the first, afterwards takes the apical direction of all the veins; it is bound to the upper offshoot by frequent cross veins forming small polygonal cells; between it and the lower externomedian vein is another very feeble intercalary arising from a cross vein, and becoming, like its lateral offshoots, nearly imperceptible toward the outer margin; as indeed do all the other cross veins and intercalaries, so that they were nearly unobserved when the margin alone was exposed, and many of the cross veins fail to compass the interspaces.

What can be seen of the internomedian vein is traceable slightly further toward the base of the wing than the preceding, but as the wing is broken here, it is impossible to say whether it is basally divided, and the portion visible is the upper branch, or whether what we see is the whole vein; in the former case the upper branch, in the latter the vein proper, runs sub-parallel to the lower externomedian, very slightly diverging from it, and in the middle of the wing (where it is broken, but where its connections leave no doubt whatever of its course) is as distant from it as the two externomedian branches at the same point; a single, distinct, pretty regularly zigzag intercalary runs midway between it and the lower externomedian branch, connected with tolerable regularity to the veins on either side by alternating, straight, transverse or oblique cross veins, generally forming rather regular, longitudinal, pentagonal cells, which become exceedingly irregular, obscure and broken next the outer margin of the wing; just below the apical offshoot of the lower externomedian branch it throws off an inferior branch, which is nearly straight, and is apically as distant from it as is the next vein above; between these branches is a very irregular intercalary vein, resembling in its connections the apical part of the intercalary above. The parts of the wing below this branch are wanting.

The relations of this insect to living types is far more obscure than in the case of Platephemera. It has certain resemblances to Platephemera and also to the carboniferous Palæodictyoptera to which it may possibly belong, but it is certain that the limits of the Ephemeridæ, even including Platephemera, are not elastic enough to admit it, and its divergence from Dictyoneura and other net-veined insects of early time is so great that its

reference there would seem to obscure its real isolation. In fact there seems to be not only no family of insects into which it can be placed, but even no sub-order living or extinct, into which it would naturally fall. There is no known insect in which five parallel and distant nervures follow the course of the costal margin, and of which only two arise from the same root; and so far as my observations have gone, I have found no neuropterous insect (to which of living groups this is plainly the most nearly allied), in which the externomedian vein is the first extensively branched vein, and in which at the same time, the upper branch of this vein is simple. In Ephemeridae (to which group one would most naturally compare it from its general appearance), the externomedian vein, as already stated, is always compound, and its upper stem is always forked. In this insect on the contrary, the upper stem is simple (which is the more remarkable from the forked character of the scapular, always simple in Ephemeridae) and the lower forked, its branches being superior and herein differing remarkably from ordinary types.

Gerephemera then is not only further removed from modern Ephemeridae than is Platephemera, but can be even less closely affiliated with Platephemera than the latter with modern Ephemeridae. It has, nevertheless, some distinctive points in common with it. Such are its great size and the probable great expanse of the internomedian area, the differing character of the net-work above and below the uppermost externomedian branch, the polygonal nature of the mesh-work caused by the cross-venation (in common with many other old insects), and the somewhat uniform character of that network next to and away from the border. In common with modern Ephemeridae, but in distinction from most other insects, must be mentioned the common feature of intercalary nervures, which here, as in Platephemera, are never free at their origin.

As points of special distinction from Platephemera may be mentioned the broad area given to the veins above the externomedian vein, the forking of the scapular vein, its course at the bottom of a deep and broad sulcus, the occurrence of a straight intercalary in the scapular-externomedian interspace, the entire structure of the externomedian vein (differing altogether from Platephemera) and the elongated slender form of the wing, which resembles much more closely Dictyoneura and Haplophlebium.

From these latter genera again, to which we should perhaps consider it most closely allied, this insect differs remarkably in the structure not only of the externomedian vein, but in the wide extent of the wings above that vein, and the number of nervures which fill it. It would appear also to differ in the character of the reticulation above the externomedian vein, a matter of less importance, but in which it agrees with Platephemera. The difference in the frame work of the wing, however, is so great and so deep seated, that there can be no doubt of at least its family distinction from all known types. Whether or no it is worthy of being classed as subordinally distinct, I leave to future discussion. But in allusion to the apparent fact that the peculiar nature of its neuration has not left its mark on modern types, I propose to call the family group in which it should be placed Atocina.[1] It will be sufficiently distinguished from other ancient types (as from modern) by the forking of the scapular vein, the course of the externomedian, its distant removal from the costal margin, and its peculiar division.

This insect and Xenoneura come from the lowest of the Lancaster Shales which furnish insect remains, called plant bed No. 2, by Professor Hartt.

[1] From the Greek ἄτοκος.

V. Homothetus fossilis. Pl. 7, figs. 1, 2.

Homothetus fossilis Scudd., Can. nat. geol., (n. s.) iii, 205, fig. 3 (1867); — Ib., Geol. mag., iv, 387, pl. 17, fig. 3 (1867); — Ib., Daws., Acad. geol., 2d ed. 524–25, fig. 182 (1868); — Ib., Amer. nat., i, 631, pl. 16, fig. 7 (1868); — Ib., Geol. mag., v, 172, 176 (1868); — Pack., Guide ins., 77–78, pl. 1, fig. 7 (1869).

Mentioned without name, as the second species, in my letter to Mr. Hartt: On the devonian insects of New Brunswick, p. 1; Bailey, Obs. south. New Br., 140; Amer. journ. sc., (2) xxxix, 357; Can. nat. geol., (n. s.) ii, 235; Trans. ent. soc. Lond., (3) ii, 117,—all in 1865.

The wing representing this insect is the most complete of the devonian insects, and would leave little to be desired were the base more complete; unfortunately the reverse of this specimen was never found, or it might supply the missing parts. To judge from the strong convexity of the costal margin, it is a front wing. It has the general appearance of a Sialid of moderate size, and the form of the wing closely corresponds. Although a fragment from the middle of the costal margin, and the whole outer half of the lower margin with the apex are missing, the form of the wing can be estimated with considerable probability. The costal margin is in general strongly convex, but is flat in the middle third, the basal portion rapidly ascending, and the apical as rapidly descending; the apex was probably rounded, but a little produced, and the hinder border pretty uniformly and fully rounded, making the middle the broadest part of the wing, where the breadth is probably contained about three times in the length; toward the base the wing narrows rapidly, but at the extreme base more gradually above so as to be almost pedunculate.

The marginal vein forms the border. The mediastinal vein is at first inclined slightly downward, then ascends as gently, parting slightly from the marginal, but again in the middle of the wing commences most gradually to approach it, running toward the extremity of the wing in close contact with it, but apparently not joining it until just before the apex and beyond the preserved part of the fossil; throughout it partakes of the course of the margin, but in a less exaggerated form, ascending slightly beyond the basal part, then straight in the middle, gently arcuate apically; it is connected with the margin, so far as can be made out, by a single straight cross vein somewhat before the middle of the wing.

The scapular vein follows a similar course as the mediastinal, always about as far removed from it as it is from the margin, excepting in the apical third; where its distance from the mediastinal is slightly greater, so as to carry its termination, no doubt, exactly to the tip of the wing; no cross veins can be seen to connect this vein with the mediastinal. No other veins can be traced at the extreme base of the wing between the scapular and the lower margin; but at a short distance (about 2–3 mm.) from the base of the scapular vein, and where its course turns from a descending to a longitudinal direction, a strong transverse vein depends from it, directed a very little obliquely outward, and reaching from one-third to one-half way to the lower margin of the wing; and from near and at the lower extremity of this stout transverse vein, other longitudinal veins arise. The uppermost arises from the middle of the lower half of the vein, at a distance from the scapular much greater than the scapular from the costal margin at this point; at first it tends upward, parallel to

the costal margin, but very soon divides into two main stems. These two stems I take to be: the upper the main scapular branch, of which the transverse vein is the base; the lower the externomedian vein, amalgamated with the former at the base, the two being comparable, as will be shown further on, to the same nervures in the Odonata. The connection of the main scapular branch with the veins preserved in the field beyond cannot be directly traced; but from the position of the latter the following account must be substantially correct. It runs in a nearly straight course to the middle of the apical half of the wing, where from not following the arcuate course of the main scapular vein it has diverged considerably from it; here its straight course suddenly terminates, but it passes to the same point on the apical margin (just below or at the apex), by a gentle arcuation subparallel to but distant from the main scapular vein, with which it appears to be nowhere connected by cross veins. This main scapular branch emits two basal and several apical inferior offshoots; the apical offshoots are thrown off at wide angles, at subequidistant intervals from the arcuate portion of the main branch, the first at its bend being abruptly and widely forked not far from its origin, the others being simple and the interspaces apparently free from cross veins. The basal offshoots are probably thrown off (their origin is destroyed) at a little distance either side of the end of the basal third of the wing; and, unlike the apical offshoots, certainly diverge at a very slight angle, and are each similarly forked; the first from the base is forked near its origin, and its upper fork is again divided narrowly about half way to the margin, the general course of all the nearvules of this basal offshoot being broadly arcuate. The other and outer basal offshoot soon runs parallel to the main scapular branch, and is connected with it by a straight oblique cross vein in the middle of the wing, where it forks; a short distance further on a piece is broken from the middle of the wing, and the part beyond is displaced a little with reference to it, and apparently folded a little so as to obscure the exact course of these forks; which seem to become involved with the fork of the first of the apical offshoots, with which, as well as with each other, they are connected by weak, inequidistant, straight, direct or oblique cross veins.

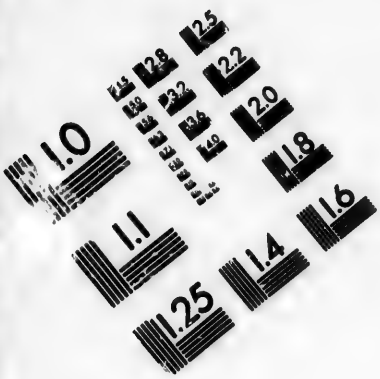
The externomedian vein can be traced in all its parts, excepting an insignificant portion of the tip of the outer of its branches; the main stem takes an arcuate course, parallel to the basal offshoot of the main scapular branch, and terminates on the lower margin just beyond the middle of the wing; half way from the transverse basal vein to the margin it throws off an inferior branch, which soon becomes parallel to it (and where it becomes so is connected by a cross vein to the vein below) and, by an interpolated vein, which appears as a baseward continuation of this inferior branch, to a bent cross vein in the same interspace, just beyond the middle of the basal half of the wing; this cross vein is bent on the externomedian side of the interspace. The internomedian vein is compound, being broken at the lower extremity of the transverse basal vein (before which it is not seen) into two compound branches, each throwing off a couple of inferior curved offshoots to the margin, which are connected together by two sets of cross veins,—one belonging only to the nervures of the upper branch, and in continuation of the direct cross nervure in the externo-internomedian interspace; the other set covering both branches and broken, each succeeding vein being carried successively further in, the general course of the whole series being across the middle of the internomedian

area, sub-parallel to the outer series; one or two of the nervules in this area are briefly forked next to the border. The anal veins cannot be seen.

The length of the fragment is 40 mm.; the probable length of the wing 42 mm.; its breadth at the middle is 14 mm., reduced at base to 4 mm.

The most important vein in this wing is the scapular, whose branches occupy about half the outer margin; the externomedian is comparatively unimportant, the internomedian occupying a larger area. The more striking features of the wing besides this are: the origination of the principal scapular branch (from which all the scapular nervules arise) and the externomedian vein from a common stem, having its source in a transverse basal nervule; and the meagreness of the transverse neuration, which in no place shows any sign of reticulation. The point first mentioned finds no parallel among insects excepting in the Odonata, where it is almost precisely similar. There, as I attempted to show many years ago in treating of the structure of the wings of recent and of fossil Neuroptera, the transverse vein termed the arculus in modern nomenclature should be considered as made up of two veins meeting each other; for the upper of the two longitudinal nervures which always originate from it belongs to the scapular vein, while the lower belongs to the externomedian. Here, these two veins appear, at least, to be amalgamated at the base, but it is not impossible, and would indeed seem *a priori* more probable, that they run side by side by side to the arculus, and are merely connate in appearance from the preservation of the fossil. However, this may be, it would seem as if we had in this peculiar structure the presence of an arculus as a forerunner at this early day of the specialized type of Odonata; the main scapular branch arising from the arculus is here, as in all normal modern Odonata, the principal vein of the wing,[1] from which most of the subsidiary branches arise; in these two points this fossil wing is distinctively and decidedly Odonate in character; but if one looks further, one fails to find expected features, now, and even in jurassic time, invariably corellated with those mentioned; especially is a nodus to be sought in vain; the marginal vein runs without break to the tip of the wing; for, although it cannot be followed from want of its perfect preservation, all the neighboring veins can, and the number is similar throughout. So too the fine meshwork of Odonate wings is not only absent, but what cross neuration exists is confined to a dozen or so straight veins for the whole wing. If, however, we consider this uppermost offshoot from the arculus as the main branch of the scapular, and simply imagine the arculus-structure removed, so as to bring this main branch directly and plainly dependant from the scapular vein, one cannot fail to see how close the entire structure would be to what we find in the Sialina. In the latter group indeed, there is no such separation of apical and basal offshoots to the main scapular branch as here, but all the scapular nervules take their rise, not from the vein itself, but as here from a principal scapular branch, arising far back on the scapular vein; the general relations of the different areas of the wing are also much the same in both, while the cross venation is very similar. Here as there, the internomedian vein and its branches are of more importance — cover a wider area and bifurcate far more — than either the externomedian vein on the one side, or the anal on the other. We have here, therefore, as I pointed out

[1] It is termed *vena principalis* in the modern nomenclature of students of Odonata. In some Calopterygidae it does not arise in the same way as in other Odonata, but has transferred its origin to the scapular (median) itself.



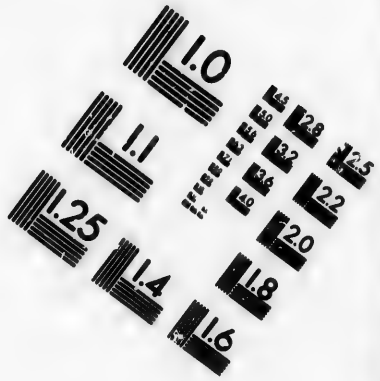
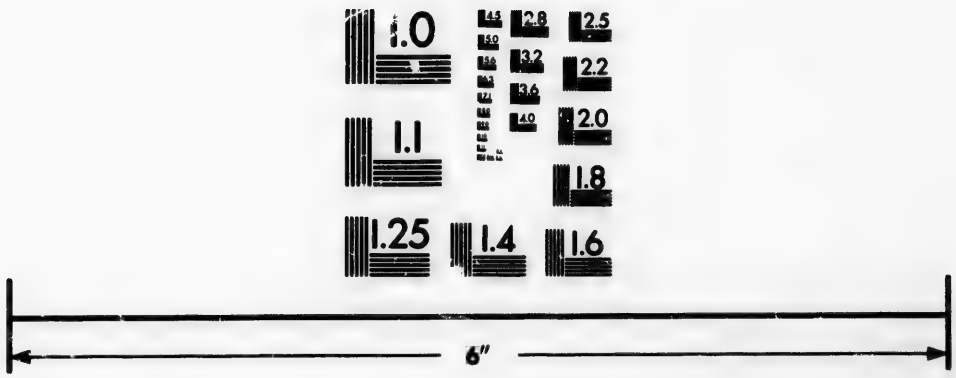


IMAGE EVALUATION
TEST TARGET (MT-3)



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when first calling attention to this fossil, the distinctive features of two tolerably well separated groups combined in one individual: certain features of the wing are distinctively Sialid in character; others occur nowhere but in the Odonata. Yet these two groups belong, one to the Neuroptera proper, the other to the Pseudoneuroptera, and we find here the earliest proof of their common origin, in a wing whose type is more distinctly synthetic than any other known. It seems also to bring new and unanticipated evidence in support of my view of the homologies of the vein arising from the arculus in Odonata.

It is plainly impossible for us to place this insect in any known family of Neuroptera. It must be considered the first known member of a family, forming the connecting link between the Neuroptera proper and Pseudoneuroptera, and will be evidence, in so far as it goes, of a closer connection between these two groups, than between the latter and Orthoptera. For this family I would propose the name of Homothetidae, and would characterize it as a family of Neuroptera (*sensu latiori*), allied to Sialina, but in which the principal scapular branch, instead of originating as in Sialina directly from the main stem, usually near the middle of the wing, arises in common with or close beside the externomedian vein, from an arculus near the base of the wing, connecting the scapular and internomedian veins; and in which, further, the basal and apical offshoots from this main scapular stem are differentiated, instead of exhibiting a similar and uniform character.

This insect was found in plant bed No. 8, of Professor Hartt's section, the highest in the series as developed at the Lancaster locality.

VI. Dyscritus vetustus. Pl. 7, fig. 4.

Dyscritus vetustus Scudd., Geol. mag., v, 172, 176 (1868).

Mentioned without name, as probably identical with one of the other species, in my letter to Professor Hartt: On the devonian insects of New Brunswick, p. 1; Bailey, Obs. geol. south. New Br., 140; Amer. journ. sc., (2) xxxix, 357; Can. nat. geol., (n. s.) II, 234; Trans. ent soc. Lond., (3) I, 117 — all in 1865.

The insect briefly mentioned hitherto under this name has not before been figured, and is the least important of the devonian wings. It consists of only a small fragment of a wing, which shows a bit of the lower margin with three or four curved veins running toward it, and connected rather uniformly with one another by cross veins forming quadrate cells. It is plainly distinct from all the others, for the equivalent region in no case is similarly broken. In *Lithentomum Harttii* the corresponding region is indeed not preserved, but the cross veins in the neighboring parts, although weak, straight and direct as here, are so very infrequent and irregular that we cannot presume the parts which are wanting below them to be very different.

The veins preserved are four in number. The uppermost has two inferior branches at short distances, of which only the extreme base of the outer is preserved, while the inner is traceable throughout its extent; it parts from the main vein, which in the brief portion preserved runs nearly parallel to the lower margin, at an ordinary angle and passes in a regular arcuate downward course to the margin. The three veins below this take a course sub-parallel to this, and are sub-equidistant; the upper, at the base of the

part preserved, is a little nearer to the vein above, and to its first branch, than to the vein below, and may possibly, not improbably, be a branch of the first vein mentioned, parting from it further toward the base than the fracture of the specimen allows us to see; the two veins below it seem to belong together; the bit of margin preserved, covering only two interspaces, is slightly convex. The cross veins are weak, but tolerably uniform, and either direct or slightly oblique, or occasionally a little irregular; they are nearly equidistant as a general rule, but more frequent in the outer of the two interspaces touching the margin than elsewhere. The length of the fragment is 15 mm.

The fragment then consists of some curved veins striking the lower margin of a wing, one at least of which is one of two or more inferior and, so far as can be seen, simple branches of a principal longitudinal vein, whose course would make it terminate either at the very tip of the wing, or, if it afterwards curved considerably, very near the extremity of the lower margin. This principal vein probably belongs either to the scapular or externomedian, while the lower curved veins appear like branches of the internomedian vein. The wing cannot therefore be referred to the vicinity of either Platephemera or Gerephemera, both on account of the relations to each other of the veins, and of the nature of the reticulation, the latter being certainly polygonal in this region in both these genera; while the irregular course of the veins themselves in Platephemera and their considerable apical divarication in Gerephemera constitute peculiarities not observed in the simple fragment under discussion. So far as the course of the veins is concerned it can be much better, and indeed very well, compared to Dictyoneura and its allies; but in all these insects the interspaces are filled with a minute polygonal reticulation (wherever it is preserved), which is such a characteristic feature that Dyscritus can by no possibility be considered as very closely allied to them.

The neuration is altogether different in Xenoneura, finding nothing at all comparable in this region. The longitudinality of the veins throughout Lithentomum seems to forbid any close comparison with it. But in Homothetus we do find some points in common with Dyscritus; for while the reticulation is much more sparse in the former, there is a certain regularity about it similar to what we have in the latter, while the curving of the internomedian veins and their parallelism certainly resemble in a general way the same features in Dyscritus. And if we presume the fragment of Dyscritus to be broken from near the middle of the wing, we may see a not distant resemblance between the longitudinal vein of Dyscritus and its two visibly connected branches, and the main branch of the scapular vein in Homothetus; while the upper, independent, curved vein of Dyscritus may be taken perhaps for the externomedian vein, and the other two nervules for branches of the internomedian vein. The resemblance is at least sufficient to make us believe we have here a clue to its relationship; while at the same time it differs so much from it that we cannot associate the two even generically; for if they are to be compared in this way at all, the lower stem of the main scapular branch, as seen in Homothetus, must either have become single and simple in Dyscritus, or it must have assumed the longitudinality and mode of bifurcation of the upper stem.

There is nothing, however, in the fragment to show what the connection of the main scapular branch may have been, and consequently nothing to prevent the reference of this wing to the Sialina, where the relations of the veins would be the same. Judging

by comparison of what we have presumed to be similar parts, we may suppose this wing to have been slightly larger than that of *Homothetus fossilis*, and its probable length not far from 50 mm.

Whatever views are held of the special homologies of the veins, its right to generic distinction from Homothetus, to which it is most closely allied, must be conceded on the ground of the greater simplicity of the neuration.

On account of the insignificance of the fragment, however, and the consequent impossibility of any sure clue to its affinities, it would not have been worth while to confer upon this wing a distinctive generic name, even granting its generic dissociation from all others, were it not for the extreme interest attaching to any insect fragment of such high antiquity.

The remains were found in plant bed No. 8, of Professor Hartt, the highest in the Lancaster series.

VII. Lithentomum Harttii. Pl. 7, fig. 3.

Lithentomum Harttii Scudd., Can. nat. geol., (n. s.) iii., 206, fig. 4 (1867); — Ib., Geol. mag., iv, 387, pl. 17, fig. 4 (1867); Ib., Daws., Acad. geol., 2d ed., 525, fig. 183 (1868); — Ib.. Amer. nat., i, 630, pl. 16, fig. 5 [*Hartii*] (1868); — Ib., Geol. mag. v, 172, 176 (1868); — Pack., Guide ins., 77, 78, pl. 1, fig. 5 (1869).

Mentioned without name, as the third species, in my letter to Professor Hartt: On the devonian insects of New Brunswick, p. 1; Bailey, Obs. geol. south. New Br., 140; Amer. journ. sc., (2) xxxix, 357; Can. nat. geol., (n. s.) ii, 235; Trans. ent. soc. Lond., (3) ii, 117 — all in 1865.

The relic to which this name has been given is the central upper portion of a wing in a very fragmentary condition, but with a bit of the upper margin sufficient to enable one to determine pretty positively the homologies of the veins. A fragment of Calamites has unfortunately covered the base and lower part of the wing, but one or two of the veins appear through it at what must be the very base of the wing, and help to determine its nature. The fragment preserved is 36 mm. long, and 15.5 mm. broad; but the wing was probably 55 mm. long, and perhaps 20 mm. broad, if one may judge from its general appearance only; it certainly represents a large insect.

The marginal vein forms the border. The mediastinal vein in the basal half of the wing, and probably for some distance beyond, runs parallel to and at considerable distance from the border, with which it is connected by very weak oblique cross veins at irregular intervals, which toward the base are considerably more oblique than further outward; this weak construction of the costal margin renders it probable that the wing was a hind one. The scapular vein in the basal quarter of the wing runs in very close proximity to the mediastinal, then parts from it a little, and continues sub-parallel to it, but a little nearer to it than the latter to the border; there appear to be no cross nervules between these veins, but a slight and irregular tortuous longitudinal line like a mere puckering of the membrane; at some distance before the middle of the wing this vein puts forth at a slight angle an inferior branch, which takes an arcuate course sub-parallel to the vein, and is forked about as far beyond the middle of the wing, apparently, as it arose anterior to it, both offshoots taking a longitudinal direction.

The externomedian vein next the base of the wing is somewhat distant from the scapular, is afterwards still further removed from it, and, in the middle half or more of the wing, has a somewhat irregular, sinuous, longitudinal course, sub-parallel to the scapular vein; just before the end of the basal quarter it appears to have a straight oblique inferior branch widely divergent from it; this is the vein next the lower margin of the fragment; by its course it would appear to be a branch of the externomedian, but it is not impossible that it may be the internomedian vein; whichever it is, it forks in the middle of the second quarter of the wing, each fork being straight, simple and slightly divergent. From the point where this inferior branch appears to be thrown off from the externomedian vein, a superior branch appears also to be emitted; it scarcely parts from the vein and runs only a short distance along the interspace in a nearly straight line and then dies out. Beyond this the externomedian vein throws off two, so far as can be seen simple, branches, which are nearly straight, obliquely longitudinal, and part from the vein, one at the middle of the wing, the other a short distance before it or just below the branch of the scapular vein. The interspaces thus formed below the scapular vein are very unequal and variable in breadth, giving the neuration a feeble uncertain appearance, which is heightened by the irregular distribution of the cross veins, which, although nearly always straight and transverse, sometimes bridge the narrowest, sometimes the broadest parts of the interspaces; they are exceedingly feeble and infrequent, the largest number being found in the interspace between the scapular and externomedian veins, although they may have been present in some of the areas where they cannot now be seen.

We shall seek in vain to accommodate this wing in any of the modern families of Neuroptera. There are none excepting the Ephemeridae, the Embidae and perhaps the Raphidiidae, in which the externomedian vein has such a preponderating importance, and in none of these do the scapular or externomedian veins have a structure at all similar. The structure of the scapular vein is somewhat similar to what we find in the Sialina, but is widely different from it in the paucity of the offshoots of the scapular branch, in which this wing is comparable to Xenoneura only. The structure of the externomedian vein is also distantly similar to that of the Sialina, but in this family, in modern times at least, the number of principal branches is always fewer, they never assume such a longitudinal course, and never cover so great an area. We must, therefore, separate this group from all known families, as one having its nearest affinities to Sialina in modern times, and perchance to Xenoneuridae in the ancient; and, considering it as in some sense a precursor of the Sialina, may call it Cronicosialina.[1] It should be looked upon as a family of Neuroptera proper, of feeble neuration, in which the scapular vein emits a main branch near the middle of the wing, which, running nearly parallel to the main vein, emits one or at most two subsidiary, also longitudinal, simple offshoots. The externomedian vein, tolerably distant from the former throughout, terminates near the tip of the wing, emitting two or three branches at very unequal distances apart, all of them longitudinal and all but the basal simple; the irregular interspaces thus formed are crossed at very unequal distances by very feeble but straight cross veins. The lower veins are unknown.

This specimen is the most obscure of all the devonian insects and would have been overlooked by any less keen-sighted observer than the late Professor C. F. Hartt.

[1] *Κρονικός*, old fashioned.

Very few persons seeing it would recognize it as an insect, yet it was the first insect found by him which he recognized as such. It is on this account that I have selected this of all the devonian wings to commemorate his discovery. It comes from plant-bed No. 8, the highest in the series.

VIII. Xenoneura antiquorum. Pl. 7, figs. 5, 6, 7.

Xenoneura antiquorum Scudd., Can. nat. geol., (n. s.) III, 206, fig. 5 (1867); — Ib., Geol. mag., IV, 387–88, pl. 17, fig. 5 (1867); — Ib., Daws., Acad. geol., 2d ed., 525–26, fig. 184 (1868); — Ib., Amer. nat., II, 163, fig. 1 (1868); — Ib., Geol. mag., V, 174, 176 (1868).

Mentioned without name, as the fifth species, in my letter to Professor Hartt: On the devonian insects of New Brunswick, p. 1; Bailey, Obs. geol. south. New Br., 140; Amer. journ. sc., (2) XXXIX, 357; Can. nat. geol., (n. s.) II, 235; Trans. ent. soc. Lond., (3) II, 117,—all in 1865; see also Amer. journ. sc., (2) XL, 271.

This fossil is represented by a fractured basal fragment of a wing, probably including a little more than half of it. It is the smallest of the devonian insects, the wing having probably measured only a little more than 18 mm. in length. It was long and slender, broadest near the middle, and probably tapered to a rounded but somewhat produced extremity, as in certain species of Dictyoneura. The costal border in the preserved portion (probably a little more than half of the whole) is gently convex; probably beyond the middle it is straight nearly to the tip, as represented on the plate; the portions of the lower margin preserved indicate that this was more strongly arcuate but not full next the base; the direction of the margins and the course of the distant veins indicate, as stated, a tapering tip, which was probably rounded, and in no way angular.

The marginal vein forms the border. The mediastinal vein is simple and gently arcuate; at first it curves gently in the opposite sense to the margin, from which it is somewhat distant, and with which it is connected by faint, nearly transverse, or, away from the base, gently oblique cross veins, not very closely approximated. At the beginning of the second quarter of the wing, it is about as distant from the scapular vein as from the margin, and thereafter runs nearly parallel with the latter, but with a slightly stronger curve, to a little past the middle of the wing; where it suddenly terminates in a cross vein bent at a right angle, the upper half a little the longer, by which it is connected with the veins on either side of it; a somewhat similar termination of this vein is shown in Goldenberg's figure of *Dictyoneura libelluloides*.

The scapular vein is one of the most important in the wing. In the part of the wing preserved it is very straight. Next to the base it is in exceedingly close proximity to the mediastinal, diverging gently from it by the curve of the latter at about the end of the basal fifth of the fragment, until it is as distant from the mediastinal as the mediastinal is from the margin, and again gradually approaches it; it is about equidistant from the border at the end of the fragment, and where the mediastinal diverges from it; beyond the tip of the mediastinal, it probably continues its straight course at first, or even trends slightly upward to take the place of the mediastinal vein, until it is in close proximity to the border, and then follows nearly the curve of the latter, gradually approaching it until

near the tip; but the track of the vein beyond the tip of the mediastinal is of course conjectural.

At a little beyond the end of the first third of the wing, it emits at a considerable angle an inferior branch, which, at about half way from its base to the tip of the mediastinal, or at just about the middle of the wing, begins to curve, so as to assume a direction parallel to the main vein, and at the same time forks; this whole branch is very faint, and is almost effaced at the fork next which the wing is fractured. To judge from the course of the other veins, one and only one of the offshoots of that branch is again simply forked; which, it would be impossible to say; but the upper offshoot (with its upper fork, if it divides) most probably runs sub-parallel to, and at considerable distance from, the main scapular vein, very gradually approaching it, especially apically where it curves downward, until it terminates, probably at the very apex of the wing. The sketch in fig. 5, however, represents the lower branch as forked, at a little past its middle; there can be little doubt that the branches impinge upon the margin at about the distance apart that is indicated, or at a little less distance apart than the branches are seen to abut on the fragment of the lower margin which is preserved. The only question is concerning the basal attachment of the vein which strikes the border the second below the scapular vein itself; if not attached as represented in the plate, it originates from the branch of the scapular vein at probably a little less than half the distance between its first forking and the apex.

The vein lying next below this, and which appears on the plate (fig. 5) to have a double attachment to the scapular vein, seems to be the externomedian vein. That its basal half, like that of the preserved portion of the scapular branch, is very faintly indicated on the stone seems due to some accident of preservation, for its apical branching part is distinct. It appears to originate from the scapular vein at a little more than half way from the base of the wing to the origin of the scapular branch; its basal portion must therefore be either connate with the scapular vein, or be so closely connected with it by the accidents of preservation as to be inseparable from it. It diverges from the scapular at the same angle as the scapular branch, is very soon connected with the adjacent vein below by a short cross nervule of unusual distinctness, bends outward a little beyond this cross nervule, and at an equal distance beyond is again bent to its former course; here it is connected to the scapular vein by a faint oblique cross vein, which is almost exactly continuous with the subsequent part of the externomedian, and reaches the scapular vein directly above the distinct cross vein above mentioned; thus giving the mediastinal vein the appearance of having a double base, and enclosing between its basal attachments an elongated subrhomboidal cell. Beyond these basal divisions the vein runs in a straight oblique course to just before the centre of the wing, where it forks widely, the upper branch being simple and excepting for a gentle arcuation at its base nearly straight and a little more longitudinal than the main stem; the lower branch nearly continues the direction of the main stem, and at a little less than half way to the margin forks, again widely, but symmetrically, the offshoot being simple, the upper again forked half way to the margin, the final upper fork being nearly horizontal and striking the border in the middle of the apical half of the wing.

The internomedian vein seems to be represented by two widely separated simple veins, the course of which, so far as they can be traced, would seem to indicate that they have a common origin very near or at the base of the wing, directly below the common stem of the scapular and externomedian veins. The upper branch first comes into view directly beneath this stem, running parallel to it, and not very far away from it, but at double the distance from it that the mediastinal vein is at this point, which is before the end of the basal quarter of the wing; when the mediastinal vein curves upward from the scapular, this curves downward in about the same degree, until it reaches the distinct short cross vein which unites it, as before stated, to the externomedian vein; here it bends downward, becomes more distinct than any of the nervules between it and the main scapular vein (previously it had been rather inconspicuous), and runs in a nearly direct faintly arcuate course to the middle of the lower margin of the wing, gently diverging throughout from the externomedian vein and its nearer branches. The lower branch is first seen in the very centre of the basal third of the wing, from which point it passes in a nearly straight course almost parallel to the distincter portion of the other branch, and is as heavily marked. The anal vein is perhaps simple, running at first downward and curving outward, subparallel to but distant from the lower basal margin, becoming just before the middle of its regular course straight and distinct, when it diverges slightly from the border of the wing, and inclines distinctly although not greatly toward the lower internomedian branch, continuing in this course until it reaches a distinct oblique cross vein which unites it to the latter in the middle of the basal half of the wing; here it bends abruptly downward at right angles to the cross vein, and runs doubtless into the margin; the cross vein is nearly transverse to the interspace in which it lies, and is about parallel to, and is of the same length as, the upper limb of the bent cross vein in which the mediastinal vein terminates. Next the basal margin of the wing is a brief simple shoot directed almost vertically downward, which may be an inferior basal branch of the anal vein. The other lines between the internomedian veins and the margin, seen in fig. 5, represent merely fractures in the stone.

Besides the three distinct cross veins mentioned,—(1) that in which the mediastinal vein terminates, (2) that between the upper internomedian branch and the externomedian vein; and (3) that connecting the lower internomedian branch and the anal vein—and the weak cross veins visible in the interspace above the mediastinal vein (of which only those in the basal half are represented in fig. 5), there are in various parts of the wing exceedingly indistinct, very weak, very closely approximated, but unequally distant cross veins, transverse or nearly transverse to the interspaces, sometimes curved but never showing any tendency to unite so as to form any kind of reticulation; it is probable that they exist throughout the wing, or at least below the main scapular vein; they are most distinct in the externomedian interspaces, and in those on either side of the internomedian branches, especially next the nervules themselves, as may be seen in fig. 5 on either side of the lower internomedian branch, where they are more distinct than in any other part of the wing; this mode of fracturing the interspaces, rather than reticulation, is the more marked from the exceedingly open and distant neuration.

Besides these normal features of neuration there are some other characteristics in this wing, purposely left for description to the end. These are some peculiar marks near the base of the wing, originally described by me as "apparently independent veinlets, forming portions of concentric rings." These ridged rings overlie the probable position, as here described, of the basal part of the lower internomedian branch, and lie just beneath the initial divergence of the mediastinal and scapular veins; they consist of an alternate series of broken concentric grooves and furrows, some faint, others in places very distinct, extending over nearly half the width of the wing at this point, *i. e.*, almost reaching the upper branch of the internomedian vein on the one hand and the anal vein on the other; the most distinct are three short, shallow furrows, with very rounded low ridges between them upon the upper side, next the upper branch of the internomedian vein; the outer of these is distant from the extreme mark upon the opposite side about 2.2 mm.; the central region, rather less than a millimeter in diameter, presents a slightly elevated, irregular, granulated surface, like many of the rougher parts of the stone outside the wing, and has no peculiar structure; the whole lies directly upon what would be the continuation of the lower branch of the internomedian vein were it present, and apparently obliterates it; one of the outermost grooves, an extremely faint and delicate one, crosses the anal vein at a very sharp angle. This peculiar feature in the wing I formerly compared to the stridulating apparatus of the Locustariae, and suggested that this insect thereby united characteristics now found only separated, some in Neuroptera and some in Orthoptera. Several naturalists, *e. g.*, Darwin, Dawson, and Packard, following my suggestion, have used this as a striking illustration of synthetic character in early types of animals, and have pictured this as the earliest example of stridulation. I am now obliged to confess that I have led them altogether astray; this peculiarity, although bearing a strong superficial resemblance to the stridulating organs in Locustariae, having, I believe, nothing whatever to do with the wing itself. The stridulating apparatus of Orthoptera, whenever it concerns the wings, is invariably based on a modification of existing veins; in its simplest forms it is the mere thickening of certain nervules, and furnishing them with a sharp or rough edge. In the original appearance of a stridulating organ in insects, we should look for some such simple form as the initial stage. But in this fossil wing we find nothing of the sort; no one of the concentric lines or grooves are continuous with any of the neighboring veins. The only appearances which favor such a view are: (1) the openness of the neuration at this point, which allows this great scar to lie at the base of the wing without disturbing more than one of the veins; (2) the curve of the anal vein, which has the appearance of passing around this obstruction; but the course of which is in keeping with the curve of the lower margin of the wing, equally explaining it; and (3) the curve of the cross veins in the neighborhood of the scar, as seen on either side of the lower internomedian branch in fig. 5; which veins, however, when narrowly examined, are seen to form angles with the more prominent concentric grooves and ridges. These ridges, too, are not of a form suitable for the production of sound, the depressions or elevations being extremely smooth and gradual; they are also of very unequal size and thickness; they do not occur in the anal area, as in all Locustariae, but in the internomedian;

and they have just sufficient regularity to render it most probable that the central, irregular, rough, and slightly elevated mass is either the relic of a foreign substance, which has fallen upon the wing, subsequent pressure upon which, when the membrane of the wing formed, so to speak, a part of the floor upon which it lay, has caused the mud and membrane together to assume the present appearance; or, that we chance here to have stumbled on a wing which, in the nymph condition, has met with some accident, producing in the imago a blister-like distortion, such as those figured by Mocquerys, as suggested to me by Dr. Hagen, in the elytra of *Carabus monilis*, *Mesonphalia gibba*, *Timarcha rugosa*, and as must have been observed in the veined wings of insects of the other orders by all entomologists. This last supposition would better account for the greater prominences of the peculiar markings around one part of the scar than elsewhere, and for the apparent partial conformity of the cross venation to the contour of the scar. Whichever way it be considered, it does not now appear to me reasonable to maintain my former hypothesis of a stridulating organ, to which nevertheless there is, as stated, a remarkable general resemblance. That such a stridulating organ would be a great anomaly no one can question, and the proposition should not be maintained in the face of the objections which careful and prolonged study and comparison elicit.

But putting aside its extraneous features, we may discuss the affinities of this insect on the basis of the unquestionable characteristics of its neuration, and shall find in these enough to excite our interest and even to perplex us. In its general features the wing is plainly neuropterous. It would appear from the strength of the margin to be an upper wing, and in its form to resemble that of many true Neuroptera; its sweeping forking branches with direct transverse cross venation attest the same proposition, but when we come to compare it with known types, we shall find it extremely difficult to place it. Its very open neuration is one general feature which is peculiar; the presence of two or three very prominent cross veins, with an extreme multitude of feeble cross veins never breaking up into an irregular reticulation, is certainly strange; so is the termination of the mediastinal vein, and still more the entire simplicity and extreme separation of the internomedian veins, occupying so large an area of the wing without a fork, and connected in so unusual a manner with the veins on either side; the apparent absolute amalgamation of the bases of the scapular and externomedian veins in such early insects is very unexpected;—and all combine to form an ensemble which is the odder for the general simplicity of the neuration. It would be hard to say which is the most prominent vein in the wing; the scapular, externomedian and internomedian occupy about equal areas, and while the two former branch more than the latter, their nervules are comparatively much feebler.

In the openness and sparseness of the neuration and in the paucity (but not at all in the position) of the principal cross veins, it bears a certain resemblance to the Coniopterygidae and to no other neuropterous family; but the differences are far greater and more important than the resemblances and scarcely need be stated.

There are also some features which give it a sialidan appearance; if we suppose, as we may, that the second nervule reaching the margin below the main scapular vein arises from the main scapular branch, we shall have a condition of the scapular vein very like that of the Sialina, excepting in the slight number of offshoots from its branch, which would be very abnormal; in the near or actual amalgamation of the externomedian

with the scapular vein, there is also nothing to separate it from the Sialina, excepting their amalgamation for so great a distance; but the structure of all the other veins and the peculiarities of the cross venation is very different from the same points in the Sialina.

In the course of most of the main veins and their mode of branching, it has some resemblance to the Raphidiidae, but it has no affinity whatever with that group in the peculiar directions of the nervules and their connection by distant cross veins, so as to form large polygonal cells, which is one of the most striking of the characteristic features of Raphidiidae.

The apical two-thirds of the wing (excluding, therefore, the attachments of most of the veins) are in sufficient harmony with these parts in the carboniferous Dictyoneurae to presume, at first, that the wing will fall in the ancient order of Palaeodictyoptera. As yet, however, we know too little of the extent and even of the peculiar characteristics of this group to say whether or not the structure of the base of the wing will allow its location here; certainly it will not admit its being placed in the same family with the genus Dictyoneura; and at present this is, perhaps, all that we can say until the structure of all the ancient wings shall have been most carefully studied.

It is in large measure in those points of structure which Dictyoneura shares with the Ephemeridae, that Xenoneura is comparable to the former, and we therefore see in this wing ephemeridan, sialidan, raphidian and coniopterygidan features, combined with others peculiar to itself. Whatever the closest affinities of the wing may prove to be, it must certainly, by its combination of characters, bridge over the gulf now separating the wing features of Neuroptera and Pseudoneuroptera; and these various considerations assure us of its family distinction from any known ancient or modern type of Neuroptera, and of the propriety of applying to the group it represents the family name of Xenoneuridae.

This species, with *Gerephemera simplex*, came from the lowest insect-producing beds of the Lancaster Shales, called plant bed No. 2, by Professor Hartt.

IX. General Summary.

It only remains to sum up the results of this re-examination of the devonian insects, and especially to discuss their relation to later or now existing types. This may best be done by a separate consideration of the following points:

1. There is nothing in the structure of these earliest known insects to interfere with a former conclusion [1] that the *general type of wing structure has remained unaltered from the earliest times.* Three of these six insects (Gerephemera, Homothetus and Xenoneura) have been shown to possess a very peculiar neuration, dissimilar from both carboniferous and modern types. As will also be shown under the tenth head, the dissimilarity of structure of all the devonian insects is much greater than would be anticipated; yet all the features of neuration can be brought into perfect harmony with the system laid down by Heer.

2. *These earliest insects were hexapods*, and as far as the record goes preceded in time both arachnids and myriapods. This is shown only by the wings, which in all known insects belong only to hexapods, and in the nature of things prove the earlier apparition of that group. This, however, is so improbable on any hypothesis, that we must conclude the record to be defective.

[1] The early types of insects. Mem. Bost. Soc. Nat. Hist., III, 21.

3. *They were all lower Heterometabola.* As wings are the only parts preserved, we cannot tell from the remains themselves whether they belong to sucking or to biting insects; for, as was shown in the essay already referred to, this point must be considered undetermined concerning many of the oldest insects until more complete remains are discovered.

They are all allied or belong to the Neuroptera, using the word in its widest sense. At least two of the genera (Platephemera and Gerephemera) must be considered as having a closer relationship to Pseudoneuroptera than to Neuroptera proper, and as having indeed no special affinity to the true Neuroptera other than is found in Palaeodictyoptera. Two others (Lithentomum and Xenoneura), on the contrary, are plainly more nearly related to the true Neuroptera than to the Pseudoneuroptera, and also show no special affinity to true Neuroptera other than is found in Palaeodictyoptera. A fifth (Homothetus), which has comparatively little in common with the Palaeodictyoptera, is perhaps more nearly related to the true Neuroptera than to the Pseudoneuroptera, although its pseudoneuropterous characters are of a striking nature. Of the sixth (Dyscritus) the remains are far too imperfect to judge clearly, but the choice lies rather with the Pseudoneuroptera or with Homothetus. The devonian insects are then about equally divided in structural features between Neuroptera proper and Pseudoneuroptera, and none exhibit any special orthopterous, hemipterous or coleopterous characteristics.

4. *Nearly all are synthetic types of a comparatively narrow range.* This has been stated in substance in the preceding paragraph, but may receive additional illustration here. Thus Platephemera may be looked upon as an ephemerid with an odonate reticulation; Homothetus might be designated as a sialid with an odonate structure of the main branch of the scapular vein; and under each of the species will be found detailed accounts of any combination of characters which it possesses.

5. *Nearly all bear marks of affinity to the carboniferous Palaeodictyoptera,* either in the reticulated surface of the wing, its longitudinal neuration, or both. But besides this there are some, such as Gerephemera and Xenoneura, in which the resemblance is marked. Most of the species, however, even including the two mentioned, show palaeodictyopteran characters only on what might be called the neuropterous side; and their divergence from the carboniferous Palaeodictyoptera is so great that they can scarcely be placed directly with the mass of palaeozoic insects, where we find a very common type of wing structure, into which the neuration of devonian insects only partially fits. For:

6. *On the other hand, they are often of more and not less complicated structure than most Palaeodictyoptera.* This is true of the three genera mentioned above with peculiar neuration, but not necessarily of the others, and it especially true when they are compared with the genus Dictyoneura and its immediate allies. There are other Palaeodictyoptera in the carboniferous period with more complicated neuration than Dictyoneura, but these three devonian insects apparently surpass them, as well as very nearly all other carboniferous insects. Furthermore:

7. With the exception of the general statement under the fifth head, *they bear little special relation to carboniferous forms, having a distinct facies of their own.* This is very striking; it would certainly not be possible to collect six wings in one locality in the carboniferous rocks, which would not prove, by their affinity with those already

known, the carboniferous age of the deposit. Yet we find in this devonian locality not a single one of the Palaeoblattariae or anything resembling them; and more than half the known insects of the carboniferous period belong to that type. The next most prevailing carboniferous type is Dictyoneura and its near allies, with their reticulated wings. Gerephemera only, of all the devonian insects, shows any real and close affinity with them; and even here the details of the wing structure, as shown above, are very different. The apical half of the wing of Xenoneura (as I have s*pposed* it to be formed) also bears a striking resemblance to the dictyoneuran wing; but the base, which is preserved, and where the more important features lie, is totally different. The only other wing which shows particular resemblance to any carboniferous form (we must omit Dyscritus from this consideration, as being too imperfect to be of any value) is Platephemera, where we find a certain general resemblance to *Ephemerites Rückerti* Gein., and *Acridites priscus* Andr., but this is simply in the form of the wing and the general course of the nervules; when we examine the details of the neuration more closely we find it altogether different, and the reticulation of the wing polygonal and not quadrate as in the carboniferous types.[1] In this respect indeed, Platephemera differs not only from all modern Ephemeridae, but also from those of other geological periods.[2] Another prevailing carboniferous type, the Termitina, is altogether absent from the devonian. Half a dozen wings, therefore, from rocks known to be either devonian or carboniferous, would probably establish their age.

8. *The devonian insects were of great size, had membranous wings, and were probably aquatic in early life.* The last statement is simply inferred from the fact that all the modern types most nearly allied to them are now aquatic. As to the first, some statements have already been made; their expanse of wing probably varied from 40 to 175 mm. and averaged 107 mm. Xenoneura was much smaller than any of the others, its expanse not exceeding four centimetres, while the probable expanse of all the rest was generally more than a decimeter, only Homothetus falling below this figure. Indeed if Xenoneura be omitted, the average expanse of wing was 121 mm., an expanse which might well be compared to that of the Aeschnidae, the largest, as a group, of living Odonata. There is no trace of coriaceous structure in any of the wings, nor in any are there thickened and approximate nervules — one stage of the approach to a coriaceous texture.

9. *Some of the devonian insects are plainly precursors of existing forms, while others seem to have left no trace.* The best examples of the former are Platephemera, an aberrant form of an existing family; and Homothetus, which, while totally different in the combination of its characters from anything known among living or fossil insects, is the only palaeozoic insect possessing that peculiar arrangement of veins found at the base of the wings in Odonata, typified by the arculus, a structure previously known only as early as

[1] Dr. H. B. Geinitz has kindly re-examined *Ephemerites Rückerti* at my request, and states that the reticulation is in general tetragonal, but that at the extreme outer margin the cells appear in a few places to be elliptical five- or six-sided.

[2] The Dictyoneurae and their allies, as may be inferred, are considered as belonging to the Palaeodictyoptera, although their ephemeridan affinities are not disregarded.

the jurassic. Examples of the latter are Gerephemera, which has a multiplicity of simple parallel veins, next the costal margin of the wing, such as no other insect, ancient or modern, is known to possess; and Xenoneura, where the relationship of the internomedian branches to each other and to the rest of the wing is altogether abnormal. If too, the concentric ridges, formerly interpreted by me as possibly representing a stridulating organ, should eventually be proved an actual part of the wing, we should have here a structure which has never since been repeated even in any modified form.

10. *They show a remarkable variety of structure, indicating an abundance of insect life at that epoch.* This is the more noticeable from their belonging to a single type of forms, as stated under the seventh head, where we have seen that their neuration does not accord with the commoner type of wing structure found in palaeozoic insects.[1] These six wings exhibit a diversity of neuration quite as great as is found among the hundred or more species of the carboniferous epoch; in some, such as Platephemera, the structure is very simple; in others, like Homothetus and Xenoneura, it is somewhat complicated; some of the wings, as Platephemera and Gerephemera, are reticulated; the others possess only transverse cross veins more or less distinct and direct. No two wings can be referred to the same family, unless Dyscritus belongs with Homothetus — a point which cannot be determined from the great imperfection of the former. This compels us to admit the strong probability of an abundant insect fauna at that epoch; although many palaeozoic localities can boast a greater diversity of insect types, if we look upon their general structure as developed in after ages, not one in the world has produced wings exhibiting in themselves a wider diversity of neuration; for the neuration of the Palaeodictyoptera is not more essentially distinct from that of the Palaeoblattariae or of the ancient Termitina, than that of Platephemera or Gerephemera on the one hand is from that of Homothetus or of Xenoneura on the other. Unconsciously, perhaps, we allow our knowledge of existing types and their past history to modify our appreciation of distinctions between ancient forms. For while we can plainly see in the Palaeoblattariae the progenitors of living insects of one order, and in other ancient types the ancestors of living representatives of another order; were we unfamiliar with the divergence of these orders in modern times, we should not think of separating ordinally their ancestors of the carboniferous epoch. It may easily be seen, then, how it is possible to find in these devonian insects — all Neuroptera or neuropterous Palaeodictyoptera — a diversity of wing structure greater than is found in the carboniferous representatives of the modern Neuroptera, Orthoptera and Hemiptera.

11. *The devonian insects also differ remarkably from all other known types, ancient or modern; and some of them appear to be even more complicated than their nearest living allies.* With the exception of Platephemera, not one of them can be referred to any family of insects previously known, living or fossil; and even Platephemera, as shown above, differs strikingly from all other members of the family in which it is placed, both in general neuration and in reticulation; to a greater degree even than the most aberrant genera of that family do from the normal type. This same genus is also more complicated in wing structure than its modern allies; the reticulation of the wing in certain

[1] Cf. Mem. Bost. Soc. Nat. Hist., III, 19, note 1.

structurally defined areas is polygonal and tolerably regular, instead of being simply quadrate; while the intercalated veins are all connected at their base, instead of being free. Xenoneura also, as compared with modern Sialina, shows what should perhaps be deemed a higher (or at least a later) type of structure, in the amalgamation of the externomedian and scapular veins for a long distance from the base, and in the peculiar structure and lateral attachments of the internomedian veins; in the minuter and feebler cross venation, however, it has an opposite character.

12. *We appear, therefore, to be no nearer the beginning of things in the devonian epoch, than in the carboniferous*, so far as either greater unity or simplicity of structure is concerned; and these earlier forms cannot be used to any better advantage than the carboniferous types in support of any special theory of the origin of insects. All such theories have required some Zoaea, Leptus, Campodea, or other simple wingless form as the foundation point; and this ancestral form, according to Haeckel at least, must be looked for above the silurian rocks. Yet we have in the devonian no traces whatever of such forms, but on the contrary, as far down as the middle of this period, winged insects with rather highly differentiated structure, which, taken together, can be considered lower than the mass of the upper carboniferous insects, only by the absence of the very few Hemiptera and Coleoptera which the latter can boast. Remove those few insects from consideration (or simply leave out of mind their future development to very distinct types), and the middle devonian insects would not suffer in the comparison with those of the upper carboniferous, either in complication or in diversity of structure. Furthermore, they show no sort of approach toward either of the lower wingless forms, hypothetically looked upon as the ancestors of tracheate Articulata.

13. *Finally, while there are some forms which, to some degree, bear out expectations based on the general derivative hypothesis of structural development, there are quite as many which are altogether unexpected, and cannot be explained by that theory, without involving suppositions for which no facts can at present be adduced.* Palephemera and Gerephemera are unquestionably insects of a very low organization related to the existing may-flies, which are well known to be of inferior structure, as compared with other living insects; these may-flies are indeed among the most degraded of the sub-order to which they belong, itself one of the very lowest sub-orders. Dyscritus too may be of similar degradation, although its resemblance to Homothetus leaves it altogether uncertain. But no one of these exhibits any inferiority of structure when compared with its nearest allies in the later carboniferous rocks, and they are all higher than some which might be named. While of the remaining species it can be confidentially asserted that they are higher in structure than most of the carboniferous types, and exhibit syntheses of character differing from theirs. It is quite as if we were on two distinct lines of descent when we study the devonian and the carboniferous insects; they have little in common, and each its peculiar comprehensive types. Judging from this point of view, it would be impossible to say that the devonian insects showed either a broader synthesis or a ruder type than the carboniferous. This of course may be, and in all probability is, because our knowledge of carboniferous insects is, in comparison, so much more extensive; but, judging simply by the facts at hand, it appears that the carboniferous insects carry us back both to the

more simple and to the more generalized forms. We have nothing in the devonian so simple as Euephemerites, nothing so comprehensive as Eugereon, nothing at once so simple and comprehensive as Dictyoneura. On the derivative hypothesis, we must presume, from our present knowledge of devonian insects, that the Palaeodictyoptera of the carboniferous are already, in that epoch, an old and persistent embryonic type (as the living Ephemeridae may be considered to-day, on a narrower but more lengthened scale); that some other insects of carboniferous times, together with most of those of the devonian, descended from a common stock in the lower devonian or silurian period; and that the union of these with the Palaeodictyoptera was even further removed from us in time; — carrying back the origin of winged insects to a far remoter antiquity than has ever been ascribed to them; and necessitating a faith in the derivative hypothesis, which a study of the records preserved in the rocks could never alone afford; for no evidence can be adduced in its favor based only on such investigations. The profound voids in our knowledge of the earliest history of insects, to which allusion was made at the close of my paper on the Early types of insects, are thus shown to be even greater and more obscure than had been presumed. But I should hesitate to close this summary without expressing the conviction that some such earlier unknown comprehensive types as are indicated above did exist and should be sought.

X. Note on the Geological Relations of the Fossil Insects from the Devonian of New Brunswick. By Principal Dawson, LL.D., F.R.S., &c.

The beds affording these remains occur in the vicinity of the city of St. John, New Brunswick, and are well exposed on the shores of Courtney Bay, on the east side of the city, and at Duck Cove, Lancaster, on its western side. They consist of sandstones, shales, and conglomerates, having an aggregate thickness of about 7,500 feet,[1] as shown in the following generalized section, in ascending order:—

1. *Bloomsbury Conglomerate* — Reddish-gray conglomerate with interstratified hard red shale. 500 feet.
2. *Dadoxylon Sandstone* — (Lower part of Little River Group in my Acadian Geology). Gray sandstone and grit, with beds of gray and black graphitic shale — Fossil plants, etc. 2,800 feet.
3. *Cordaite Shales* — (Upper part of the Little River Group) — red, gray and black shales, with beds of sandstone and conglomerate — Fossil Plants, etc. 2,400 feet.
4. *Mispec Conglomerate* — Red conglomerate and shale. 1,800 feet.

In the vicinity of St. John, these beds rest on cambrian rocks of the Acadian (Menevian) group, and are overlain uncomformably by lower carboniferous ("sub-carboniferous") conglomerates, which in their extension eastward are associated with the Albert shales holding fossil fishes and plants of characteristic lower carboniferous types.[2] Elsewhere in

[1] Report of Bailey and Mathew, Geol. Survey of Canada, 1871. In the author's Acadian Geology, the thickness is given as 9500 feet; but later observations have reduced the thickness of the lower members.

[2] See for details the author's Acadian Geology, 3d Edition.

Southern New Brunswick, they overlie laurentian and huronian rocks, and are seen to rise unconformably from beneath the carboniferous rocks of the great central coal-formation area of New Brunswick.[1] They are everywhere more disturbed and altered than the overlying carboniferous beds; and Messrs. Bailey and Matthew have shown that certain intrusive masses and dykes of granite, known to be of pre-carboniferous age, were erupted subsequently to the deposition of these beds.

The vegetable fossils of this formation are very numerous. I have catalogued or described from it upwards of 50 species, belonging to the genera Dadoxylon, Sigillaria, Calamites, Asterophyllites, Lepidodendron, Cordaites, Psilophyton, Neuropteris, Sphenopteris, Hymenophyllites, Pecopteris, &c.; the whole constituting a well-marked devonian assemblage, distinguishable from the upper devonian flora of Perry in Maine, which is perhaps newer than the Mispec conglomerate, and still more distinct from the lower carboniferous flora of New Brunswick and Nova Scotia, while on the other hand it is incomparably better developed than any known flora of silurian age. Owing to the richness of this flora, and to the fact that some genera and species of plants appear earlier in North America than in Europe, some European palaeobotanists have been unwilling to admit the devonian age of this formation, but entirely without good reason.

That some of the species of the St. John beds, as *Calamites transitionis* (=*C. radiatus* of Brongniart), are found in the lower carboniferous of Europe, is not wonderful, as in the devonian as well as in subsequent periods the flora of America has been somewhat in advance of that of Europe. Still the prevalent plants in the St. John beds are distinctively erian or devonian and not carboniferous. Further, recent discoveries of tree-ferns and petioles of ferns in great abundance in the devonian of New York, and as low as the Hamilton group, have shown that the devonian must have been even more remarkable than the carboniferous for the abundance and variety of its ferns. A few additional species of ferns found among specimens remaining in Professor Hartt's collections will shortly be described.

The crustaceans recognized in these beds are *Eurypterus pulicaris* Salter; *Amphipeltis paradoxus* Salter, a precursor of the Stomapods; and a pygidium of a small trilobite, unfortunately too imperfect for determination. A species of *Spirorbis*, which I have described as *S. erianus*,[2] occurs attached to leaves of Cordaites, and is distinct from the common *Spirorbis* of the coal-measures (*S. carbonarius* or *pusillus*). A fragment of a spiral shell may possibly represent a devonian pulmonate, and will be noticed in a forthcoming paper on the pulmonates of the carboniferous. No other animal remains have been found in these beds, except fossil insects. The conditions of deposit were probably estuarine rather than marine, and the abundant fossil plants testify to the proximity of land.

It is difficult to correlate the subdivisions of the devonian in eastern Canada, with those in the great erian area of New York and western Canada, owing to the absence of the marine limestones, so characteristic of the latter. In my report on the fossil plants of the devonian and upper silurian of Canada,[3] I have, however, stated some grounds

[1] Bailey and Matthew's Reports, which see also for details of the structure and relations of the devonian and associated formations, in southern New Brunswick.

[2] Report on devonian plants. Geol. Surv. Canada, 1871.

[3] Geol. Survey of Canada, 1871.

for believing that the Dadoxylon sandstone and Cordaite shales may be equivalents of the Hamilton group in New York and Ohio, which has afforded some fossil plants comparable with those of the St. John beds, especially trunks of conifers of the genus *Dadoxylon* (*Araucaroxylon*). The horizon of the fossil insects of St. John would thus be middle devonian.

In the finer shales of this series, the remains of plants are very perfectly preserved, the most delicate leaves having not only their outlines but also their nervature represented by films and lines of shining graphite, resembling pencil drawings on a dark gray ground. The insect wings are preserved in a similar manner.

The discovery of the insect remains is wholly due to the late Prof. C. F. Hartt, who, with the aid of other gentlemen, members of the Natural History Society of New Brunswick, removed by blasting large quantities of the richest fossiliferous beds and examined them with great care. The extreme rarity of these remains renders it probable that but for the large quantities of material examined by Professor Hartt, they would not have been found; while the extreme delicacy of the impressions would have prevented them from being observed except by a very careful collector scrutinizing every surface in the search for leaflets of ferns, preserved in such a way as to be visible only under the most favorable light. These unusually perfect explorations should be taken into the account in any comparisons made of the fossils of this locality with those of other places.

The following detailed section of the Little River Group, at the Fern Ledges, Lancaster, N. B., where the insects occur, is derived from Professor Hartt's paper in Bailey and Matthew's report before alluded to, and is substantially the same as given in my Acadian Geology.

Section at the "Fern Ledges." (*Order ascending.*)

Heavy beds of gray sandstone and flags (Dadoxylon sandstone). *Dadoxylon ouangondianum* Daws., *Calamites, etc.* Thickness, by estimation, 300 feet.

Under this head I have classed all the beds underlying the Plant-bed No. 1, which I am disposed to regard as the lowest of the rich plant-bearing layers, and the base of the Cordaite shales. These beds occupy the low ground lying between the ridge of the Bloomsbury group and the shore. They are covered by drift, and show themselves only in limited outcrops, and in the ledges on the shore. In the western part of the ledges they are thrown forward on the beach by a fault, forming a prominent mass of rock, in the summit of which a fine trunk of *Dadoxylon* is seen embedded in the sandstone. Recent excavations made in these beds in quarrying stone for building purposes, in the eastern part of the locality, where the rocks are very much broken up by dislocations, have exposed numerous badly preserved impressions of large trunks of this tree.

PLANT-BED NO. 1. . . . . Thickness, 1 foot.

Black arenaceous shale, varying from a fissile sandstone to a semi-papyraceous shale, very fine-grained and very fissile, charged most richly with beautifully preserved remains of plants, among which are the following species:—

Calamites transitionis Goeppert. (*C. radiatus Br.*) Occasional, in large, erect specimens.—*Asterophyllites latifolia* Daws. Extremely abundant, often showing ten or twelve whorls of leaves, sometimes with many branches.—*A. acicularis* Daws. Also

very abundant.—*A. scutigera* Daws. The curious stems of this species, with their scale-armed nodes, occur abundantly in this bed.—*Sphenophyllum antiquum* Daws.—*Pecopteris obscura* Lesqx.—*Sphenopteris* sp.?—*Cardiocarpum cornutum* Daws. Rare.—*Psilophyton elegans* Daws. Occasional. I have never detected any trace of *Cordaites Robbii* Daws., in this bed. It is extremely common in the overlying strata.

Gray sandstones and flags, with occasional ill-preserved plants, *Calamites transitionis* Goeppt.—*Cordaites Robbii* Daws.—*Asterophyllites and Sternbergiae* . 2 feet 6 in.

Black arenaceous shales of the same character as those of Plant-bed No. 1, but without fossils, so far as I have examined . . . . . 11 inches.

Compact flaggy, gray sandstone, with badly preserved plant remains, *Calamites*, etc. . . . . 2 feet.

Very soft, dark, lead-colored shales, much slicken-sided and charged with fragments of plants. This bed is so soft that the action of the weather and the sea have everywhere denuded it to the level of the beach . . . . . 4 feet.

PLANT-BED No. 2 . . . . . 1 foot.

At the point where the section crosses the bed, and where I first discovered it, it consists of very compact and hard, light lead-coloured, slate-like, arenaceous shale; but the character of the shale varies much in its different exposures, being sometimes very soft and fissile, and of a very black colour. The following is the list of species which it affords:—

Calamites transitionis Goeppt. Occasionally; never in good specimens.—*C. cannaeformis* Brongn. Occasionally; never in good specimens.—*Asterophyllites acicularis* Daws. Rather rare.—*A. latifolia* Daws. Rather rare.—*A. longifolia* Brongn. (?). Rather rare.—*A. parvula* Daws. Whorls of a minute *Asterophyllites*, which may belong to this species, are not infrequent in this bed.—*Sporangites acuminata* Daws.—*Pinnularia dispalans* Daws. Abundant.—*Psilophyton elegans* Daws. Quite common, always in fragments, never in good specimens.—*P. glabrum* Daws. Flattened stems, with a wavy woody axis traced in a brighter line of graphite, occur in this bed, but always in fragments.—*Cordaites Robbii* Daws. Extremely abundant, and very fine specimens may be obtained, especially from the upper part of the bed, and rarely specimens showing the base or the apex of the leaf.—*Cyclopteris obtusa* Lesqx. Occurs very abundantly in detached pinnules.—*C. varia* Daws. Rare.—*Neuropteris polymorpha* Daws. Extremely abundant, never in large fronds.—*Sphenopteris Hoeninghausii* Brongn. Quite abundant, often in fine fronds.—*S. marginata* Daws. Abundant, in fine fronds.—*S. Hartii* Daws. Very rare.—The original specimen came from this bed.—*Hymenophyllites Gersdorffii* Goeppt. Rather rare.—*H. obtusilobus* Goeppt. Rare.—*H. curtilobus* Daws.—*Alethopteris discrepans* Daws. Amongst all the abundance of plants afforded by Plant-bed No. 2, I have detected only one or two pinnules of this fern, which appears first in abundance in Plant-bed No. 3. It is afterwards one of the most common species.—*Pecopteris ingens* Daws. Very rare, only two or three fragments of pinnules having been found.—*Trichomanites* (?) Only a single specimen, probably, as Dawson has suggested, only the skeleton of a fern.—*Car-*

diocarpum cornutum Daws. Abundant, and very finely preserved, never attached —*C. obliquum* Daws. Quite abundant, also never attached.— *Trigonocarpum racemosum* Daws. Rare.—*Eurypterus pulicaris* Salter. The occurrence in Plant-bed No. 2 of this minute crustacean was first detected by my friend Mr. George Matthew. It is very rare, not more than four or five specimens having been found by Messrs. Matthew, Payne, and myself at the time of the description of the species by Salter. I have since that time succeeded in collecting nearly twice as many more, some of which appear to belong to a new species.—*Amphipeltis paradoxus* Salter. The specimen figured in Salter's paper was found by Professor Dawson and myself, in breaking a piece of shale in my cabinet, that came from this bed. Only one other specimen has since been obtained. It consists of two or more of the thoracic segments, and was collected by Mr. Lunn. It is in the collection of the Natural History Society of New Brunswick. In addition to the above species, this bed has afforded the following:—*Cyclopteris*, sp. nov—*Neuropteris*, sp. nov. A single specimen collected by Mr. Lunn.—*Sphenopteris*, sp. nov.—*Spirorbis erianus* Daws. The leaves of *Cordaites* in the upper part of the bed are as thickly covered with a little *Spirorbis* as are the fronds of the recent fucoids of the Ledges. The specimens are poorly preserved. — *Trilobites*. Mr. Payne collected a minute trilobite from from this bed, but it proved not determinable.—*Insect Remains!* In the summer of 1862, I discovered an organism in Plant-bed No. 2, which at the time I could make nothing of; but which I have since proved to be the wing of an insect. Several weeks after, I found in Plant-bed No. 8 an unequivocal insect's wing. This discovery was followed by that of others, my father, J. W. Hartt, finding another in this bed. [The insects of this bed are GEREPHEMERA SIMPLEX and XENONEURA ANTIQUORUM.]

Compact flaggy sandstone, quite barren . . . . . 5 feet 10 inches.

PLANT-BED No. 3 . . . . . 10 inches.

Black and lead-colored shales, quite compact in upper part, but in lower very crumbling, splitting irregularly, slicken-sided, often with polished surfaces, and traversed by thin quartz-veins. These shales are so soft that the sea and weather have everywhere denuded them to the level of the beach. There are now no exposures of the bed workable. The following are the fossils which occur in it:—

Calamites transitionis Goeppt. Occasionally. — *C. cannaeformis* Brongn. — *Asterophyllites latifolia* Daws. Very beautiful whorls of this plant are very common here, the whorls, though usually detached, being sometimes found united three or four together.—*Sporangites acuminata* Daws. Common.—*Pinnularia dispalans* Daws. Common.—*Psilophyton elegans* Daws. Occasionally.—*P.*(?) *glabrum* Daws. Occasionally.—*Cordaites Robbii* Daws. Extremely abundant, but not so well preserved as in Plant-bed No. 2. Leaves usually appear as polished bands of graphite, with venation obliterated.—*Cyclopteris obtusa* Lesqx. Not very abundant. —*Neuropteris polymorpha* Daws. In beautiful specimens, common.—*Sphenopteris marginata* Daws. Not common.—*S. Hoeninghausii* Brongn. Not common.—*Pecopteris* (*Alethopteris*) *discrepans* Daws. It was here that I first discovered this species. It occurs quite abundantly, but always in fragments.—*Cardiocarpum cornutum* Daws. Quite common.—*C. obliquum* Daws. Quite common.

Coarse sandstone, full of obscure casts of *Sternbergiae* and *Calamites* .	6 feet	6 inches.
Soft shale and fissile sandstone, with *Calamites*		3½ "
Sandstones	2 feet	8 "
Shale with obscure remains of plants		2½ "
Sandstones, barren, so far as examined	4 feet	10 "
Sandstone and shale, with a few *Calamites* and *Cordaites*		9 "
Sandstone and coarse shale, with obscure markings	5 feet	10 "
Light greenish, coarse shale, with fern-stems, *Cordaites*, and obscure markings, *Carpolites* (?)		7 "
Sandstones and coarse shales, with badly preserved vegetable remains	18 feet	9 "
PLANT-BED No. 4.	1 foot	0 "

Coarse shales, affording at the point where the line of section crosses it: —

Cordaites Robbii Daws.—*Calamites transitionis* Goeppt.—*Neuropteris polymorpha* Daws.—*Psilophyton glabrum* Daws.—*Pinnularia dispalans* Daws.

I have examined at two different points, in the eastern part of this locality, a bed which appears to correspond to this. It is characterized there by a very beautiful *Neuropteris*[1] (*N. Dawsoni* Hartt) with long linear lanceolate pinnules decurrent on the rachis, to which they fo: a broad wing. The pinnules are often four inches in length. This is one of the most beautiful ferns occurring at the locality. Several other new forms are associated with it. Among these is a magnificent *Cardiocarpum*, nearly two inches in diameter (*C. Baileyi* Daws.).

Sandstone with obscure markings	9 feet	6 inches.
PLANT-BED No. 5		6 inches.

Soft, fine-grained light-greenish shale.

Cordaites Robbii Daws. Extremely abundant. — *Calamites cannaeformis* Brongn. Found occasionally.—*Psilophyton* (?) *glabrum* Daws.—(?) *Asterophyllites acicularis* Daws. — *Alethopteris discrepans* Daws. Quite abundant.—*Sphenopteris marginata* Daws. Quite abundant.—*Pecopteris*, sp. nov. (?) — *Hymenophyllites* sp. (?)—*Neuropteris polymorpha* Daws. Very abundant—*Spirorbis* occurs in the bed, attached to the leaves of *Cordaites*. I have never detected it in any of the beds higher up.

Compact flaggy sandstones and coarse shales, with a few plants. . . .		8 feet.
PLANT-BED No. 6.		2 feet.

Fine-grained and light-coloured shale, with great abundance of *Cordaites Robbii*, and *Calamites transitionis*; above that a layer of coarse shale, with *Cordaites* and stems of plants badly preserved; then a layer of soft, very friable shale, with few fossils; and lastly, a layer of coarse shale of a greenish-gray colour, with: —

Alethopteris discrepans Daws. Abundant.—*Cordaites Robbii* Daws. Abundant.—*Calamites cannaeformis* Brongn.—*Neuropteris polymorpha* Daws.—*Cardiocarpum cornutum* Daws.—*Cardiocarpum obliquum* Daws.— *Pecopteris*, sp. nov. Occurs abundantly in some of the overlying beds.

Sandstones and coarse shales, with abundance of plant remains, principally *Cordaites* and *Calamites*		5 feet.

[1] This plant belongs to a new genus, subsequently named Megalopteris. Report on devonian plants of Canada, 1871.

PLANT-BED No. 7 . . . . . 2 feet.

This is one of the richest plant-beds of the section. The shales composing it vary much in character in different exposures. They are for the most part of a gray colour and compact, like a fine-grained sandstone, though they pass into a light brownish, very fissile, soft shale, and there are some layers of a very black colour.

Cordaites Robbii Daws. Very abundant, and in a beautiful state of preservation.—*Calamites transitionis* Goeppt. Not abundant as good specimens.—*C. cannaeformis* Brongn. Rare.—(?)*Asterophyllites acicularis* Daws. In very beautiful specimens, very common in certain thin layers. There are two or three other species, occurring also in the overlying beds, which appear to be new.—*Sporangites acuminata* Daws. Extremely plentiful.—*Pinnularia dispalans* Daws. Extremely plentiful.—(?) *Psilophyton elegans* Daws. I have obtained several specimens of a *Psilophyton* growing in tufts, and closely resembling this species.—*Neuropteris polymorpha* Daws. Occasional.—*Alethopteris discrepans* Daws. Abundant, and obtainable in good specimens.—*Cyclopteris obtusa* Lesqx. Occasional.—*Sphenopteris marginata* Daws.—*Hymenophyllites subfurcatus* Daws.—*Cardiocarpum cornutum* Daws. Quite abundant.—*C. obliquum* Daws. Quite abundant.—*C. Crampii* Hartt.—*Alethopteris Perleyi* Hartt.—*Sphenopteris pilosa* Daws.—Several other plants not yet determined.—*Insects.* A single insect's wing was obtained from this bed by my father and myself. [PLATEPHEMERA ANTIQUA.]

Compact sandstone and coarse shales (barren of fossils) . . . . . 3 feet.

PLANT-BED No. 8. . . . . 1 foot 10 inches.

Fine-grained, tough, but fissile sandstones, rather coarse shales, often of a greenish cast, and at the top a thin layer of very black shale very rich in plants. The middle portion does not contain so many plant remains, but the lower is as well stocked as the leaves of an herbarium. The following are the fossils I have collected from it:—

Cordaites Robbii Daws. As usual in great profusion, and in very fine specimens.—*Calamites transitionis* Goeppt. Occasional.—*C. cannaeformis* Brongn.—(?) *Asterophyllites acicularis* Daws. Quite common, together with one or two other species apparently new, which occur also in Bed 7.—*Annularia acuminata* Daws. Extremely common, especially in certain layers.—*Pinnularia dispalans* Daws. Abundant.—(?) *Lycopodites Matthewi* Daws. Rare.—*Cyclopteris obtusa* Lesqx.—*Cyclopteris*, sp. nov.—*Neuropteris polymorpha* Daws. Quite frequent in detached pinnules.—*Hymenophyllites subfurcatus* Daws. Very common.—*Alethopteris discrepans* Daws. This is the most abundant fern in this bed. It occurs usually in detached pinnules, though not unfrequently in considerable fronds.—*Alethopteris.* Besides the above, there are three or four other species, some of which occur also in Beds 6 and 7[1].—*Cardiocarpum cornutum* Daws. Not very common.—*C. obliquum* Daws. Also not very common.—*C. Crampii* Hartt. Quite common.—Several other species of plants not yet determined.—*Insects.* Two species, two specimens. One was obtained by my friend, Mr. James Hegan. [Three insects were obtained from the bed: HOMOTHETUS FOSSILIS, DYSCRITUS VETUSTUS and LITHENTOMUM HARTTII.]

[1] Probably the species afterwards described (Dr. Dawson's Report of 1871) as *Alethopteris Perleyi* Hartt, *Pecopteris serrulata* Hartt, and *Pecopteris preciosa* Hartt.

Sandstones and coarse shales, with badly preserved *Cordaites Robbii* Daws., *C. transitionis* Goeppt., and *Alethopteris discrepans* Daws.	26 feet.
Fine-grained, light-greenish shale, with obscure remains	1 foot.
Sandstone and shales, with *Calamites* and obscure markings	23 feet.
Total thickness of the beds embraced in this section . . .	440 feet, 11 inches.

XI. EXPLANATION OF PLATE VII.

Fig. 1. *Homothetus fossilis* (magn. ⅔). The dotted lines are conjectural; the break in the dotted line representing the outer border indicates the presumed amount of separation at that point to account for the bending of the outer piece of the wing.

Fig. 2. *The same* (1). With no parts restored.

Fig. 3. *Lithentomum Harttii* (1). The dotted lines show the presumed connection of the basal veins with the other fragment.

Fig. 4. *Dyscritus vetustus* (1).

Fig. 5. *Xenoneura antiquorum* (⅔). The dotted lines indicate the supposed course of the veins and border where they are not preserved. A portion of the base is shaded to show the exact appearance of the concentric ridges; this basal portion is mostly drawn from the same stone as fig. 7, but the small fragment unshaded, at the extremity of the anal vein, and the cross vein are drawn in from the reverse of fig. 5, shown in fig. 6; so also is the larger apical piece with part of the lower margin, these two parts being more complete on the reverse than on the obverse.

Figs. 6 and 7. *The same* (1). With no parts restored. The apical fragment of fig. 7 is not represented; it exists, but is not so complete as in fig. 6.

Figs. 8 and 8ª. *Gerephemera simplex* (1). The two independent lines at the extremity of the costal margin are inserted from a drawing made under the camera when only these lines and the outer margin with the tip of the veins were exposed; in working out the rest of the wing these were broken away, but are here restored. The arrow indicates the direction of 8ª, which represents the contour of the surface of the wing, the upper dotted extremity indicating the costal margin (shown to the left of the arrow), and the dots along its course the position of the veins it crosses.

Fig. 9. *Platephemera antiqua* (1). The faint line of dashes above the marginal vein represents the margin of the wing, indicated on the stone by a slight darkening of the surface The dotted lines at base and at tip indicate the presumed form of the wing.

Fig. 10. *The same* (1). This figure, the reverse of fig. 9, is so placed in relation to the preceding as to indicate the probable expanse of wing of this insect; a fragment at the lower angle of this specimen is not preserved in fig. 9, which possesses a bit of the outer margin not found in this.

Figs. 1, 2, 4, 6, 8, 10 represent specimens preserved in the museum of the Natural History Society of St. John, N. B.

Figs. 3, 7, 9 represent specimens in the museum of the Boston Society of Natural History.

Fig. 5 is a composite drawing from the specimens in each museum. The Boston Society of Natural History possesses the reverse of a small portion of fig. 8; and the St. John Society the reverse of No. 3, neither of which are engraved.

The plate was executed by Messrs. Sinclair & Son of Philadelphia.

Archipolypoda, a Subordinal Type of Spined Myriapods from the Carboniferous Formation.

All the paleozoic myriapods which have been published, only fifteen nominal species in all, have been referred to the Diplopoda or Chilognatha as they are variously termed. Among them are species which seem to bear a very close general resemblance to modern Iulidae, and some of them have even been described under the generic name Iulus. Others, however, first made known as myriapods by Messrs. Meek and Worthen in 1868, in the Proceedings of the Philadelphia Academy of Natural Sciences, and in the same year figured in the third volume of the reports of the Illinois Geological Survey, differ strikingly from modern types in the presence of rows of very large forked and branching spines upon the surface of the body. These naturalists were able also to show the probability that a fossil from the coal measures of England which Mr. Salter had referred to the crustacean genus Eurypterus belonged in the same group, and more recently Mr. Henry Woodward has pointed out that not only this form, but another, known since the publication of Brodie's work on the English Fossil Insects in 1845, and which was supposed by Westwood to be the larva of Saturnia, a genus of Lepidoptera, should certainly be referred to this group of spiny myriapods; and to the list Woodward has also added another species.

Having enjoyed the opportunity, through the kindness of Messrs Carr, Worthen and Pike,[1] of examining a considerable number of specimens of these curious fossils — all from the ironstone nodules of Mazon Creek, Illinois — I bring here the results of my study, which show that these spined myriapods, while allied to the Diplopoda rather than to the Chilopoda, certainly form a very distinct type, which was no doubt the precursor of the Diplopoda; and it appears very probable that even those paleozoic species which have been supposed to resemble closely the modern Iulidae were also spined, and may therefore be presumed to have resembled their evidently spined relations in other points of structure in which the latter are distinguished from modern forms. The reasons for this belief will be given further on.

One main distinction between the two groups, Diplopoda and Chilopoda, into which modern Myriapoda have been divided, consists in the relation of the ventral to the dorsal plates of the body segments. In the Chilopoda there is a single ventral plate, bearing one pair of legs, to every dorsal plate. In the Diplopoda, on the contrary, there are

[1] A considerable number of specimens, including some new species, having been sent me after the first presentation of this paper to the Society, through the kindness of Messrs. Carr, Pike, Armstrong and Bliss, advantage has been taken of the delay in its publication to introduce into the text descriptions of all such additions. (Jan. 31, 1882).

two such ventral plates, each bearing a pair of legs, to every dorsal plate (with the exception of a few segments at the extremities of the body). The Diplopoda are universally considered the lower of the two in their organization and it is therefore not surprising to find that no Chilopoda have been found in rocks older than the tertiary series, while myriapods with two pairs of legs corresponding to each dorsal plate range back through the entire series of rocks to the coal measures.

This being the case, in any comparison which we may make between the ancient and modern types we may leave the Chilopoda entirely out of account, and confine our attention to the points of distinction between the ancient types and the modern Diplopoda. At first we shall confine ourselves, in speaking of the ancient forms, to the large-spined species alone, many of which attain a gigantic size. The head and its appendages, wherein are found the greatest divergencies of structure in the different modern forms, are again so poorly preserved in the carboniferous species that our comparisons must be drawn almost entirely from the structure of the body segments, which are mainly a repetition one of another throughout the body.

Fig. 1. Cross section of a modern Diplopod. The lines inside the ring mark the separation of the dorsal and ventral plates.

Fig. 2. Side view of a segment of a modern Diplopod.

In modern Diplopoda, each of the segments of the body is composed in large part, almost entirely, of a dorsal plate forming a nearly complete ring, for it encircles nine-tenths of the body as a general rule, leaving scanty room for the pair of ventral plates (see Fig. 1). On the side of the body (Fig. 2) it is perforated by a minute foramen, the opening of an odoriferous gland; usually the ring is nearly circular, but occasionally the body is considerably flattened and the sides are sometimes expanded into flattened laminae, with a smooth or serrate margin; a few species are provided with minute hairs, sometimes perched on little papillae; and the surface of the body, ordinarily smooth or at best wrinkled, is occasionally beset with roughened tubercles which may even form jagged projections. So far as I am aware, no nearer approach to spines occurs on this dorsal plate than the serrate edges of the lateral laminae, the roughened tubercles or the papilla-mounted hairs. In the ancient forms from the coal measures we find a very different condition of things. The body segments may be nearly circular, or they may be laterally compressed, or, as in many modern types, depressed; but in all, the dorsal plate occupies at most apparently only two-thirds of the circuit of the body, being met by broad ventral plates (see Figs. 3, 4). This

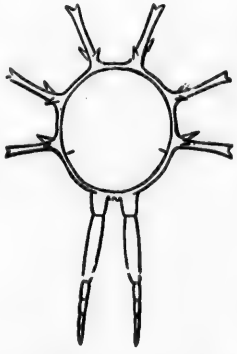

Fig. 3. Cross section of a carboniferous Archipolypod. The lines inside the ring mark the separation of the dorsal and ventral plates.

Fig. 4. Side view of a segment of a carboniferous Archipolypod.

dorsal plate is not perforated for foramina repugnatoria,[1] but as means of defence it is armed with huge spines upon either side; one row (for they occur on all the segments) lies above, near the middle line of the body; another lies low down upon the sides near the lower margin of the dorsal plate; and a third row is sometimes interposed between them.[2] These spines are similar in all the rows, but differ in the different species; in few probably are they simple but provided with spinules to a greater or less extent. In the most bristling the spines are forked at the tip, and besides this have a basal corona of stout spinules; others have such a whorl of spinules in the middle of the spine; in nearly all the spines are at least half as long as the width of the body, and sometimes they are nearly as long. These spines are in themselves very remarkable and resemble nothing that I can discover in modern Arthropoda,[3] unless it be certain thorny spines seen in the early stages of some Crustacea, and especially of some found on the tail piece of cirrhiped larvae figured by Claus, to which Mr. Alexander Agassiz has called my attention. Some of his own unpublished drawings of the young of our common barnacle exhibit still closer resemblances, although even here it is not very marked. These spines are fixed, and one can readily picture the difference in external aspect between one of these creatures a foot or more in length, bristling all over with a coarse tangle of spines, and the smooth coiling Iulus of the present day. (See Pl. 7[a].)

If we pass, however, to the ventral plates we shall find differences of even greater significance. In the modern Diplopoda, as already remarked, these plates are minute; they are similar in size and form; the anterior one forms the anterior edge of the segment, continuous with that of the dorsal plate; together, however, they are not so long as the dorsal plate at their side, and the latter appears partly to encircle the posterior plate by reaching inward towards the coxae of the legs; the legs are attached at the posterior edge, and those of the opposite sides are so closely crowded together that they often absolutely touch each other (Fig. 1); the stigmata, of which there is a pair to each ventral plate, are placed at the outer edge rather toward the front margin; they are minute, and have their openings longitudinal as regards the animal, *i. e.*, they lie athwart the segment; the coxae of the legs of the anterior plate are therefore opposite the stigmata of the posterior plate. No other organs are found upon the ventral plates; one might indeed say there was not room for them. The legs themselves are composed of six cylindrical simple joints, subequal in length, the apical armed with a single terminal claw; the whole leg is short, rarely more than half as long as the diameter of the body.

In the ancient types all is very different. In the first place the ventral plates, which are of equal size, occupy the entire ventral surface, and perhaps may be said to extend partly up the sides of the rounded body, and no part of the dorsal plate passes behind the

[1] This is what would be expected from the presence of spines; two such means of defence should not be looked for in the same animal; odoriferous glands are present only in slow-moving, or otherwise defenceless creatures, as in Phasmidae among Orthoptera for example.

[2] In one species there is only one row of spines on either side, situated where the third row occurs in the trebly spined forms.

[3] Since this was written, Mr. J. H. Comstock has shown me his capital drawings of Coccidae and pointed out to me forked spines, microscopic indeed, fringing the last abdominal segment of the female, and occurring, he says, only in the sub-family Diaspinae.

The spines of these myriapods have nothing to do with the barbed hairs on the body of the embryonic Strongylosoma as figured by Metschnikoff (Zeitsch. f. wiss. Zool., XXIV, pl. 26, fig. 1 *a*.). These latter are comparable with the dermal appendages of the embryonic larvae of Lepidoptera. See my Butterflies, pp. 28-32, figs. 36, 37.

the posterior ventral plate; they are together equal in length to any part of the dorsal plate, the rings of which the body is composed being equal; while in modern Diplopoda the dorsal portion of the dorsal plate is always considerably longer than the ventral portion, allowing the creature to coil ventrally without exposing any intersegmental portion of the back devoid of hard armature; while in these ancient forms, the animal appears to coil dorsally as readily as ventrally; at least, when not extended straight upon the stones in which they are preserved, they are as frequently found bent upward as downward — or perhaps more frequently; and there is nothing certainly in their structure to prevent it. Indeed in one species, *E. flabellata*, the ventral plates seem to be divided on either side in the middle, apparently allowing of even greater flexibility, which the arrangement of the posterior dorsal plates for a terminal flap, apparently for aquatic propulsion, would perhaps require in an unusual degree. Then the legs, instead of being inserted at the extreme posterior edge of the plate, originate from almost its very centre, and are indeed so large that they nearly occupy the whole of it, a thin lamina only being left at the posterior edge of the coxal cavities, though a wider space remains in front; neither are they inserted close together, but are removed from one another by a space equal to their own width, so that they have ample play (Fig. 3). The legs themselves (see Pl. 8, fig. 11) differ from those of modern types in having the second joint as long as the others combined, and the whole leg as long as the diameter of the body, sometimes nearly twice as long; moreover they are not cylindrical but compressed and slightly expanded, strengthened also on the flattened surface by longitudinal ridges, and have in every respect the aspect of *swimming legs* in those specimens in which the appearance of the legs is most clear. No modern aquatic myriapods are known. The spiracles, instead of being minute and having the position seen in modern Diplopoda, are very large, situated in the middle of each ventral plate (Fig. 4), each spiracle opposite to and indeed touching the outside of the coxal cavity of the plate to which it belongs, and running therefore with and not athwart the plate, *i. e.* across the body; its length equals the diameter of the large coxal cavities.

But in addition to these structures, which make up the sum of the furniture of the ventral plates in modern Diplopoda, we find in these ancient types some further interesting organs, which are so perfectly preserved that no doubt can be entertained concerning their presence and their adherence to the ventral plates. The coxal cavities are not circular but oval and are situated with the major axis in an oblique line, running from near the middle line of the body forward and outward; this, and the slight posterior insertion of the legs leave even a wider space between them on the anterior edge of the plates than posteriorly, and this place is occupied by a pair of peculiar organs (see Fig. 3 and Pl. 8, figs. 1-4), situated one on either side of the median line at the very front edge of the ventral plate; to these it seems to be impossible to assign any other function than that of supports for branchiae; they consist of little triangular cups or craters projecting from the under surface, through which I believe the branchial appendages protruded; so far as I am aware, no other organs than branchiae have been found in any Arthropoda situated within the legs, and repeated on segment after segment; a single exception may perhaps be made of Peripatus, in which Balfour has found segmental organs having their external openings somewhat similarly situated; but this being the only known instance of their

presence in arthropods[1]; branchiae also occurring in not a few instances nearer the medioventral line of the body than the legs, and branchiae and spiracles coexisting even in the true insects, and then in somewhat similar relative positions (though the branchiae in these instances have never been found next the medioventral line); and the presence further of swimming legs leading us to presume in these creatures an aquatic or amphibious mode of life: I believe we may fairly conceive these cup-shaped organs to be branchial supports, and that we are dealing here with a type of myriapods very different from any existing forms,—suited to an amphibious life, capable of moving and of breathing both on land and in water. Moreover the assemblage of forms discovered in these Mazon Creek beds lends force to this proposition; for the prevalence of aquatic crustacea, of fishes and ferns indicates, what the presence of marsh-frequenting flying insects does not contradict, that the fauna and flora was that of a region abounding in low and boggy land and pools.

These however are not the only points in which the ancient forms differed from the recent. The modern forms are of uniform size throughout, while the ancient, at least when seen from above, tapered noticeably toward either end and especially toward the tail, the largest part of the body being in the neighborhood of the seventh to the tenth body segments, which were often two or even three times broader than the hinder extremity, and considerably broader than the head or the first segment behind it. A single segment seems to have carried all the appendages related to the mouth parts, while in modern types two segments are required for this purpose. This is inferred solely but sufficiently from the fact, even more remarkable, that every segment of the body (as represented by the dorsal plates), even those immediately following the head, is furnished with two ventral plates and bears two pairs of legs. As is well known, the segments immediately following the head-segments in modern Diplopoda have each only one ventral plate and bear only a single pair of legs, — a fact correllated with the embryonic growth of these creatures, since these legs and these only are developed at about the time of hatching. The mature forms of recent Diplopoda therefore here resemble their own young more than do these carboniferous myriapods, a fact which is certainly at variance with the general accord between ancient types and the embryonic condition of their modern representatives, and one for which I can offer no explanatory suggestion worth consideration.

These remarkable points, in which the structure of the carboniferous myriapods are found to be distinguished from modern Diplopoda, none of which (with the single exception of the least important, structurally considered, viz. the spined appendages) have before been pointed out, seem to warrant our placing them in a group apart from either of the modern suborders of myriapods, and of a taxonomic value equivalent to them. For this group, the name Archipolypoda is proposed.

Unfortunately the preservation of the appendages of the head in these ancient types has not proved sufficiently good to allow much comparison between them and modern types. This is the more to be regretted since these parts are those on which we depend largely for our judgment of the relationship of the Myriapoda to other Insecta and to Crustacea. If they were present and clearly defined we may well suppose that they would afford some clew to the genetic connection of these great groups.

[1] Attention should be drawn in this place to Ryder's recent observations on the anatomy of Scolopendrella, and especially of its tracheal system (Amer. Nat., XIV, 375), the external openings of which are "inside the bases of the legs."

There are certain features, however, common to most, at least, of these ancient types, which should be mentioned; these are the great breadth and depth of the head, which is the more remarkable from the tapering of the anterior extremity. In one or two specimens also the antennae have been more or less completely preserved (see Pl. 10, figs. 7, 13, 18), and appear to differ little from their modern representatives unless it be in their greater slenderness and brevity, possibly resembling more the embryonic condition of modern types. What appear to be eyes are also preserved in one or two instances (Pl. 8, fig. 10, and Pl. 10, fig. 18), and also present no contrasts worthy of special mention.

Besides these, careful examination has shown in specimens of not less than four species of two genera, the presence of a long and straight unjointed appendage, or pair of appendages, upon the under surface of one of the early segments of the body (the fourth, fifth or sixth), which varies in length from one-half the width of the body to more than its width. It is always entirely different from the spines and clearly not one of the ordinary legs. No other external organ is known in this part of the body in modern Myriapoda, excepting the pair of intromittent organs, which are morphologically legs, supplanting them on the sixth segment, and it seems, therefore, highly probable that we have in these ancient types a movable organ of the same nature, but of an exceedingly simple character. Full description of each instance is given in the text.

The results reached by a study of these spined myriapods of the Mazon Creek nodules lead naturally to the enquiry what their relations were to other paleozoic myriapods. In some of these previously studied [1] I have pointed out what I then believed to be foramina repugnatoria. These are described in *Xylobius sigillariae* Daws., where one specimen is said to have "a slight circular depression in the centre of one of the frustra . . . about half way up the sides of the segment; it resembles and is found in the place of the lateral pores." Also in *X. fractus* Scudd., where "a slight depression, probably a lateral pore, may be seen in the centre of one of the middle frustra of each segment" (only two segments were preserved in this specimen). And also in *Archiulus xylobioides* Scudd., where they occur "from the seventh segment . . . at least to the seventeenth . . . and are placed in the middle of the sides of the segments; they are oblong oval in shape, with their longer diameters vertical; the mean of their diameters averaged 0.2 mm." in specimens the diameter of whose body is about 4 mm. In a subsequent page of the memoir, mention is made of the "large size" of the lateral pores.

In *Iulus Brassi* described by Dohrn [2] he says he was unable to find any foramina, but states that Kner thought he had recognized stigmata on some segments above the legs; "er glaubt an einigen Ringen oberhalb der Beine den Abdruck von Stigmen zu erkennen; gewisse Punkte," adds Dohrn, "an diesen Stellen kann man gewiss dafür ansehen, wenn schon ihre wirkliche Natur nicht zweifellos festzustellen ist".

Woodward in his description [3] of the British *Xylobius sigillariae* (*X. Woodwardi* Scudd.) says: "each segment of the body, wherever sufficiently well preserved to show it, bears upon its lateral portion a slightly raised whart, indicating the position of the pores, stomata or tracheal openings." These are figured in his plate, in fig. 11a, as nearly one-eighth the diameter of the body.

[1] The Carboniferous Myriapods preserved in the sigillarian stumps of Nova Scotia. Mem. Bost. Soc. Nat. Hist., Vol. II, pt. 2, No. 3 (1873).

[2] Verh. naturh. Ver. Rheinl., [3], V, 535-536, taf. 6.

[3] Trans. Geol. Soc. Glasgow, II, 236, pl. 3 (1867).

The great size of these lateral marks struck me, at the time my paper was written, as inconsistent with their reference to the foramina repugnatoria, but there did not then seem to be anything else to which they could be compared. A re-examination of a few specimens of the sigillarian myriapods in my possession, coupled with the statements of Woodward and Dohrn, lead me now to the conclusion that these marks are the scars or bases of spines, which appear as warts or tubercles in many of the Mazon Creek myriapods, or, in casts or views of the interior surface, as pits of greater or less dimensions. Their position would entirely accord with this. Add to this the fact that all of these Iulid-like carboniferous myriapods had a decidedly fusiform body (some more than others) tapering somewhat toward the head and a great deal toward the tail; and that the legs where preserved are of unusual length—both of these features peculiar to the spined myriapods of the Mazon Creek nodules: and I think we may fairly consider it probable that they too possessed some at least of the other features characteristic of the latter, and should be hypothetically classed, until proof to the contrary is found, among the Archipolypoda.

In this paper however no further attention will be paid to these smaller Iulidiform types, which were not improbably wholly terrestrial in habit, and may very likely have formed a distinct family of Archipolypoda, to which I have already applied the term Archiulidae, and which, in addition to the characteristics mentioned in the paper upon them, were not improbably distinguished from the Mazon Creek myriapods, to which the family name of Euphoberidae may be given, in the absence of branchiae.

It only remains, before proceeding to the discussion of different forms of Euphoberidae, to point out that we have in these Archipolypoda still another proof of the close alliance of the fauna of Europe and America in paleozoic times. The genera Xylobius, Acantherpestes and Euphoberia, including ten of the twelve species of myriapods found in American carboniferous rocks are all represented in the coal measures of England. I shall be able in future papers, from material already in my hands, to point out among other insects additional evidence of great interest in this direction, and shall hope at no distant day to offer lists of the carboniferous insect faunas of Europe and America in parallel columns, so as to bring clearly to the eye this prominent feature of early insect life.

The number of forms of Archipolypoda represented in the carboniferous rocks has proved unexpectedly great. By the kindness of several friends, mostly residents of Morris, from whence the ironstone nodules, in which most of them were found, come, I have been able to study twenty-six specimens, which with the eight previously known belong to twelve distinct species and four different genera. The genera are distinguished in part by the form of the segments, and in part by their armature; Acantherpestes having three rows, Euphoberia two rows, and Amynilyspes one row of spines on either side of the body, while in Eileticus, spines are absent and their place supplied by a series of warts. Euphoberia is far the most abundant in species, Acantherpestes having only two, and Amynilyspes and Eileticus one each.

Order MYRIAPODA.

Suborder ARCHIPOLYPODA.

Paleozoic myriapods, with a fusiform body, largest near the middle of the anterior half or third, the head appendages borne upon a single segment; each segment behind the head composed of a single dorsal and two ventral plates, the dorsal of nearly uniform length superiorly and inferiorly, occupying most of the sides as well as the top of the body; destitute of foramina repugnatoria, and divided into a ridged anterior and flat posterior portion, the anterior provided with longitudinal rows of spines or tubercles; the ventral plates occupying the entire ventral portion, each bearing a pair of long jointed legs, and furnished outside of them with large spiracles, the mouth transversely disposed.

Family EUPHOBERIDAE.

Archipolypoda armed with very large forked or branching spines, occasionally reduced to tubercles, running in several uniform rows along the back or sides of the body, and attached to the dorsal plates; the legs compressed, the second joint much longer than any of the others and the whole adapted to swimming; those of opposite sides well separated at base, and having between their insertions a pair of branchial appendages.

Genus ACANTHERPESTES (*ἄκανθα, ἕρπω.*)

Acantherpestes Meek and Worthen, Geol. Surv. Ill., III, p. 559 (hypothetical).

Spines bifurcate at tip and arrayed in subdorsal, pleurodorsal and lateral rows. Segments three or more than three times as broad as long.

The name Acantherpestes was suggested for one of the species which falls within this group by Messrs. Meek and Worthen, in case it did not agree with the genus Euphoberia (to which the species itself was referred with question marks) in having two ventral plates corresponding to each dorsal plate. This it does possess, as indeed the very figure they present shows, two pairs of legs being pictured as corresponding to each dorsal plate. Notwithstanding this, and notwithstanding the impropriety of suggesting hypothetical or conditional names for animals whose affinities are not clearly understood, the name is a good one, and rather than burden our heavily taxed science with synonymy, it is brought into requisition.

Acantherpestes major.

Pl. 7ª, 8, figs. 1–4, 6–8, 10, 11.

Euphoberia?? major Meek and Worthen. Amer. Journ. Sc. Arts, [2], XLVI, 25–27; —*Ib.*, Geol. Surv. Ill., III, 558–559, fig. (1868).

The figure was reproduced by Woodward in the Geol. Mag., X, p. 105 (1873), and also in his Monograph of the Merostomata, p. 172, fig. 62 (1872).

The specimens upon which this species was founded were very fragmentary, the one figured consisting of only seven segments with a part of one spine, the spine-bases and several imperfect legs. Two other specimens have been placed in my hand by Mr. J. C. Carr,

one of which is very perfect and of enormous size, and which was first shown me by Prof. J. W. Pike; the other though only fragmentary is the more interesting because it exhibits the ventral plates more clearly than any other specimen of Archipolypoda yet discovered. A third specimen with its reverse, representing a younger individual, has more recently been placed in my hands by Mr. Pike.

In the specimen figured in the Illinois Report, and which by the kindness of Professor Worthen we are able to reproduce here, we have a lateral view, apparently of the anterior part of the cylindrical body a little curved downward, in which the scars of the lower spines and the mammiform bases of the other series are present, besides one or two of those of the uppermost row upon the further side of the body. The width of the body shows how huge the creature must have been. Judging by comparison with the most complete one I have seen, it must have been three decimeters or just about one foot long; "it probably attained a length of 12 to 15 inches" say the describers. The segments, which are about three times as broad as long, are divided transversely into two parts, the arched anterior portion a little longer than the flat posterior part and bearing the spines. The surface is apparently smooth. The spines are altogether wanting beyond their bases with the exception of a single fragment in the uppermost row; and this is evidently one of the basal spinules and not the spine itself, being comparatively small, simple and conical. The bosses and scars, however, show that there was a subdorsal row of spines tolerably near the mediodorsal line, another at the lower portion of the dorsal plate and a third pleurodorsal row considerably nearer the former than the latter. The legs are mostly broken off near their bases, but two or three are longer, and one is represented in the figure (not mentioned in the text) as complete, being regularly conical, shorter than the body, and divided into five nearly equal joints; I cannot doubt that this and the apparent joints of the other legs are either given quite inaccurately or that at all events the marks do not represent the joints of the legs. The length of the fragment is 62 mm. and its width 21 mm.

Fig. 5. *Acantherpestes major.*

The most complete specimen seen (Pl. 8, figs. 6-8, 11), exhibits a side view of apparently the entire creature, the greater part of the body in a straight line, but the anterior part curved a little upward; along the entire upper line the spines of the subdorsal series may be seen, many of them very perfect; the position of the other rows may be traced by the pits in the body itself, while legs, many of them almost perfect, may be traced along nearly the entire lower margin. The body is cylindrical or nearly cylindrical in form, perhaps a little higher than broad, tapering forward from the seventh or eighth segment so as to be from one fifth to one fourth smaller; and backward from the twelfth or thirteenth segment very uniformly and gradually, so as to be at tip only about one half the greatest breadth. The whole length of the body is 207 mm., its greatest breadth 16 mm. There can hardly be any doubt that the whole animal is preserved. The rapidly tapering form of the extreme hinder extremity with the change in the characteristics of the spines make it certain that the body ended here; at the front extremity the first segment has every

appearance of being the termination of the body, and an appendage, presumably an antenna or a part of one, is attached at the upper margin of the front; it would also be in keeping with the general form of these animals as shown by the study of all the species if this anterior segment were the head.

This head segment is only about half the size of one of the nearer body segments, rounded, higher than long, the front rather flattened, and bearing in front, above, a straight antenna composed apparently of three joints, the basal joint equal, small, cylindrical, slender, longer than broad, the apical oblong ovate, twice as broad as the others and four or five times longer than broad; the whole antenna is 6 mm. long, of which two thirds belongs to the apical joint, whose greatest diameter is 0.9 mm. From the lower outer angle of the head projects a bundle of spines (?), which afterwards diverge into three nearly straight rods; they evidently do not belong where they are, but their structure and surface appearance give them the aspect of spines and not of legs; the triangular offshoot from them appears to have no connection with them, but to be an accidental mark in the stone.

The segments of the body behind the head are forty in number, and of a similar size; where the body is broadest the length of the segment is 5.5 mm., and this proportion of length to breadth holds tolerably well throughout, the segments being about three times as broad as long. They appear to be strongly arched and more equally than would appear to be the case in the next specimen to be described, although some segments seem to present an anterior, broad, rounded side where the spines are seated; certainly the segments are deeply and coarsely incised. A large part of the body and of the spines (Pl. 8, fig. 8) are covered with circular flattened raised disks of a yellowish color (Pl. 8, fig. 7), with a slightly raised rim and either a depression or a slight elevation at the centre, crowded closely together and appearing as if formed of the dried up contents of the body; the outside of the spines seem to show them quite as much as the inside of the same; indeed the outside of the spines appears to be entirely made up of them. They are usually about 0.5 mm. in diameter, but a considerable number are smaller and show no structure; the head, antenna and the trifid appendage of the head are all furnished abundantly with them, but they are entirely absent from the legs.

The only spines that are preserved belong, apparently all of them, to the subdorsal row, but the openings into the hollow interiors of those which are necessarily concealed indicate clearly that there are three rows upon either side, arranged exactly as described in the specimen figured by Messrs. Meek and Worthen. The spines of the subdorsal rows (Pl. 8, fig. 8) are cylindrical, equal, hollow throughout, rather longer than the diameter of the body, rather deeply and equally forked at tip, so as to appear Y-shaped, the branches not very divergent; at the base, (in the anterior part of the body), or near the same (in the posterior part of the body), is at least a pair, but more probably a whorl, of subsidiary spines springing from the main stem; anterior and posterior spinules are preserved at the base of nearly all the spines, but there are also indications of others which lie interiorly and exteriorly, and which necessarily cannot be very clearly exhibited in a fossil like this; such an indication appears at the base of Pl. 8, fig. 8, representing the spine enlarged, where a rounded hollow seems to prove a spinule in addition to those in front and behind, as clearly as the other pits in the body walls indicate the position of the principal spines; they appear to originate at the very base of the spine throughout the body and to be less divergent

than the other spinules; of the front and hind spinules, the posterior is generally longer and slenderer than the anterior, and situated higher upon the stalk; the double set of holes next the base of the legs in several segments of the body indicates that this was the case also with the lateral spines; these spinules are longer on the posterior part of the body than on the anterior, and have about the same angle from the main stem as the terminal forks from each other. The spines occur, one to a segment in each row, on every segment behind the head; on the penultimate and antepenultimate the main spine seems to end where the spinules spring out, and the latter are of unusual length; on the last segment the same arrangement occurs, though the spinules are very short. The main spines are of uniform size throughout most of their extent, but enlarge slightly above where they fork, and below where the spinules diverge; the spinules are generally tapering and pointed, but in the front part of the body the anterior and posterior ones are stout, often scarcely taper, and are bluntly tipped. The length of the spines is from 12–13 mm., and they are 1.6 mm. in diameter in the middle.

The legs[1] (Pl. 8, fig. 11) are better preserved than in any other of the Archipolypoda examined; the creature is crushed in such a way that one sees in a groove, running beneath the dorsal plates for the greater part of the body, the interior surface of the basal joints of the lower lying legs (the remaining portions of which are buried in the matrix), and just below these upon the plane of the dorsal plates, the exterior surface as well as all the rest of the legs of the upper lying or nearer pairs. They consist of six joints. The first is about twice as long as broad on a side view, narrowing a little at either end; it is about as broad as possible, the series occupying almost the entire space below the segments so as to crowd against each other; it is apparently a little compressed, the outer surface furnished with a distinct longitudinal carina at both anterior and posterior edge and furnished also with a very prominent and stout median longitudinal carina, which is generally a little curved; corresponding to which on the inner face is a rather deep and very abrupt sulcation. The second joint is very different; it is laminate, nearly equal, considerably narrower than the basal joint, very long, being more than six times as long as broad; it has a distinct median carina, at least on the outer side, or perhaps the slightly convex sides are pinched or angulate along the middle; in some instances the one, in others the other appears to be the case, even on adjoining legs. The third joint exactly resembles the second, except in being shorter; it has about the same width, and the same median carina, but it is only about half as long again as broad, equal, quadrate and laminate. The fourth joint is of the same length as the third, but slenderer, a little tapering and with only slight trace of the median carina. The fifth is as long as the fourth, continues the gentle tapering of the leg so as to be nearly half as broad as the second joint, and has no carina. There is pretty certainly another still slenderer and apparently cylindrical joint of about equal length beyond this, but it is only preserved in one or two instances and in part. Nothing positive can be asserted of the claw, but one leg appears to have a single slender gently curving claw of considerable length. The legs are at first sight apparently shorter at the two ends of the body than in the middle, but this is due simply to imperfect preserva-

[1] Between the tips of two of the legs may be seen a crushed molluscan shell, having the appearance of a minute Planorbis, considered by Dr. Dawson (Proc. Bost. Soc. Nat. Hist., xxi, 157) as Spirorbis (Microconchus) carbonarius.

tion, measurements of the second joint showing no difference whatever. The length of the first joint is 2.4 mm.; of the second 7.75 mm.; width of same 1.2 mm.; length of third joint 2.2 mm.; of fourth joint 2.2 mm.; of fifth joint 2.2 mm.; of sixth joint 2.mm.; of the whole leg as it lies on the stone 21 mm. So far as the legs are preserved there are two pairs to every dorsal plate; the stone is broken away next the last two segments so that they do not show there, one only appearing on the penultimate, none on the last segment; the same is true in front, so that none appear on the first segment behind the head, and only one on the second segment; but this one is placed posteriorly, leaving room for an additional one in front of it on the same segment.

Along the ridges which separate the bases of the two sets of legs (of opposite sides) from each other can be seen remnants of the branchial cups to be mentioned further on, but in a fragmentary and often somewhat displaced condition; enough however to show clearly to one who has studied the specimen next to be described that they were present here throughout the greater part of the body, as they can be traced in various parts.

Both relief and intaglio of this specimen are preserved and have helped to reconstruct the myriapod as we have attempted to depict it. They belong to Mr. J. C. Carr of Morris, Illinois, from whom, through the kind intervention of Mr. J. W. Pike, in whose hands I first saw it, it was received for study.

Notwithstanding its far greater incompleteness, the next specimen (Pl. 8, figs. 1-4) of this species to be mentioned rivals the one just described in interest and importance, on account of its perfect exhibition of the ventral plates. It consists of only a few segments from the stouter part of the body, probably presenting an oblique view, mostly dorsal, with a cast of the same. In the breaking of the stone, the part representing the former under crust of the animal has in a small part of the fossil parted from the upper crust, so that in looking upon the dorsal surface one sees also, in the central part of the fossil, the interior view of the ventral plates; and its cast represents, no doubt with tolerable faithfulness, the appearance of the under surface of the ventral plates. The body is a little curved and the posterior segments parted from one another. The convexity of the upper surface of the body well appears, but the form of the body cannot further be told from this specimen. The fragment is 67 mm. long as it lies, but this should be reduced to about 58 mm. to allow for the displacement of the posterior segments. It is 17-18 mm. broad and shows no sign of tapering; probably it is a fragment from the broadest part before the tapering had commenced; on that supposition its size indicates a creature rather larger than the complete specimen last described, but not so large as that described by Meek and Worthen. Eleven segments are present, four anterior ones in their natural relations showing the dorsal plates; then three, also connected with one another and the preceding, but of which the dorsal plates are gone, revealing the inner surface of three pairs of ventral plates; and finally four more dorsal plates separated from one another by more than their own length. The dorsal plates are from 3.75-4.5 mm. long and therefore about four times as broad as long, their anterior half bearing a broadly rounded, elevated, transverse ridge with mammiform knobs which are the broken bases of the spines; the posterior edges of the segments are also a little thickened and slightly elevated, giving the appearance of a slight transverse ridge at this point. The surface appears to be almost or quite smooth; in one or two points a delicate granulation may be seen under a strong lens, and next the hinder edge of

some of the segments there appears to be a feeble wrinkling or faint corrugation of the surface. In general only the bases of the spines are present, which so far as can be determined show a disposition very similar to what is seen in the other specimens, but exhibit more clearly than they the relation of the subdorsal series to each other as to distance, showing that they are almost as far removed from each other as they each are from the pleurodorsal series; one or two spines also of this latter series remain and by their structure show that they probably did not differ at all from those of the other series, unless possibly they were slighter and shorter.

The legs do not appear, but on the ventral plates their insertion is plainly visible (Pl. 8, figs. 2-3), showing that the basal joints were probably obliquely appressed, for the coxal cavities are obovate and directed toward the anterior outer edge of the ventral plate next in advance of that on which they are seated; they are also seated a little posteriorly upon the ventral plate, for they reach its posterior edge, but are separated from the anterior border by about one third their own shorter diameter; those of the same ventral plate are also separated from each other by a space equal to at least their own longer diameter.

In the flattened part showing the ventral plates, these extend just as far laterally as the dorsal plates, and the distance from the outer edge, which is preserved upon one side, to their median line is even greater than to the median line of the dorsal plates, showing certainly that they had a wide extent and covered at least the entire under surface of the body; they were of equal size throughout, narrowing only at their extreme lateral extension where they appear to have been rounded. Their length is 2.25 mm. Outside the base of each leg and abutting upon it are the large oblong-ovate spiracles (Pl. 8, figs. 2-3), running transversely to the body, and showing as a deep groove with a very thin laminate ridge along the middle; they are 2.5 mm. long, 0.6 mm. broad. Lying next the front edge of each ventral plate and on either side of the medioventral line of the body, almost attingent at their slightly swollen bases, are the branchial cups (Pl. 8, figs. 2-4), which appear from within as sunken pits, rounded triangular in form, two sides of the triangle being formed by the median line of the body and the front edge of the segment, the latter being the longer; all the angles are well rounded; the floor of this pit is flat, but depressed around the edges, so that the deepest part forms a groove just at the base of the bounding walls; the surface of the floor has in some a spongy aspect with an appearance of converging laminae, but this is not clear; these branchial pits are a third as broad again as long, being 1 mm. in breadth and about 0.75 mm. in length. When viewed from the cast showing these organs as they probably appeared upon the outside of the body (Pl. 8, fig. 4), they appear as crater-like elevations, the rim of which is suboval rather than triangular, with the posterior inner angle of the boundary wall somewhat higher and thicker than the rest; the floor presents nearly the same aspect as in the other face.

This specimen was sent to me by Mr. Pike after I had seen and studied the large and perfect specimen last mentioned. In studying that I had become convinced of the possible aquatic life of the creature from the structure of the long paddling legs, and stated my belief at a meeting of the Boston Society of Natural History held October 20, 1880. It was therefore with no small pleasure that I subsequently found my conclusions supported in so remarkable a manner by the discovery of these structures on a second individual of the species. Another specimen received from Mr. Carr is as small as that last mentioned and

more imperfect, consisting of only a dozen segments or less of the front portion, with scarcely any appendages. It is of particular interest, however, from partially preserving the eye of one side (Pl. 8, fig. 10); it forms an oval boss 3 mm. long and 1.5 mm. broad, gently elevated above the principal curve of the head, situated low down on the anterior portion of the head, its longer diameter vertical; it is covered with nearly hemispherical, low, circular warts about 0.16 mm. in diameter, crowded rather closely but not attingent, and scattered about over the whole convexity with a slight indication of serial arrangement. The length of the fragment is 36 mm. and its breadth about 10 mm.

The last specimen I have to mention was sent to me by Mr. Pike and represents the larger part of a young individual curled in a broad sigmoid curve. Sixteen or seventeen consecutive segments besides the head are preserved, all poorly; the spines and legs are everywhere fragmentary and add nothing to the other specimens; the diameter differs only a very little at different parts, though the usual enlargement of the segments a little way behind the head is indicated. The head itself appears to be larger than the segments behind it, but is very badly preserved. The points of interest in it are: first, that the basal joints of a leg may be seen on the first segment behind the head; second, that the ventral plates, where seen, are divided by a distinct suture into anterior and posterior portions, as does not appear in the other specimens where ventral plates are preserved, but as occurs in some specimens of Euphoberia; and third, that from near the posterior extremity of the sixth (?) segment behind the head, there projects downward a long, straight, stout, cylindrical, bluntly terminated rod, as long as the width of the body, the apical apparently a little stouter than the basal half, suggesting, as in other cases to be mentioned, an intromittent organ. The length of the specimen as it lies is 83 mm.; if straightened it would measure about 97 mm. in length; its diameter is 11 mm.; and the length of the rod mentioned 10 mm.; the greatest diameter of the latter is 1.25 mm.

This species differs from the next to be mentioned in the much less rapidly tapering form of the body, in the proportionally shorter segments, and in the character of the spines, which in this species are longer bodied, rather less divergently and much more equally branched at tip, and are furnished with basal spinules of a remarkable character which are not apparent in the other.

Acantherpestes Brodiei Scudder.

Pl. 8, fig. 5.

"Caterpillar" Westwood in Brodie, Foss. Ins. Eng., xvii, 105, pl. 1, fig. 11 (1845).

Eurypterus? (*Euphoberia*) *ferox* (pars) Woodward, Geol. Mag., X, 109–110, fig. 10 (1873).

Arthropleura ferox Woodward, Monogr. Merost., 172, fig. 63 (1872).

Euphoberia ferox Roemer, Leth. geogn., pl. 47, fig. 4 (1874).

Not *Eurypterus ferox* Salter.

This species has been known through Brodie's Fossil Insects for many years, but it is only recently that its relationship was determined. This is partly due to its fragmentary nature, for it is pretty evident from what we now know of the spined myriapods of the carboniferous period that the specimen is considerably imperfect, the head (and perhaps two or three

segments more) being absent from the front end and a considerable number of segments at the tail end. It presents a dorsal view of ten segments in the stouter part of the body, enough however to show that it tapered somewhat toward the head and very considerably behind the thickest portion of the body, so that the hinder portion seen is only half as broad as the broadest, only six or seven segments distant; the body has every appearance of having been cylindrical; the fragment is 55 mm. long and 18 mm. broad in the widest part. The segments show a well arched transverse ridge on the anterior portion, which seems generally to occupy much the largest part of the segments, but there is an irregularity about this in the engraving which would seem to be defective; as a whole they are from three to four times as broad as long. The three rows of spines are clearly marked, partly by the spines themselves and partly by the tubercles which mark their former origin; these show the rows to have been equidistant from one another, the subdorsal rows being as far apart as either from the pleurodorsal; the spines are preserved only in the lateral rows; these appear to be uniform, subcylindrical, nearly or quite half as long as the width of the segments (counting to the forks of the spines), expanding at the tip and bearing a couple of stout spinules, the hinder and longer of which is as long as the body of the spine, tapering and pointed, directed slightly backward, and according to Westwood "evidently articulated" at the base; the front and shorter spinule is short, tapering and pointed, directed a little forward. There is no appearance of any basal thorns.

This species may be easily distinguished from *A. major* by its decidedly more tapering body, comparatively shorter and broader segments and the character of the spines, which not only appear to lack the basal thorns, but are very unequally forked at the tip.

The specimen comes from the carboniferous rocks (ironstone?) of Coalbrook Dale in England, and is in the Hope collection at Oxford.

Genus EUPHOBERIA. (*εὖ, φοβερός.*)

Euphoberia Meek and Worthen, Am. Journ. Sc. Arts, (2), XLVI, 25 (1868). — *Ib.*, Geol. Surv. Ill., III, 556.

Spines spinuliferous, but with a single pointed tip, and arranged in subdorsal and lateral rows only; segments less than three times, generally about twice, as broad as long, rarely less than twice as broad as long, and then only upon a few segments of the body.

Euphoberia ferox.

Pl. 9, fig. 23.

Eurypterus ? (*Arthropleura*) *ferox* Salter, Quart. Journ. Geol. Soc. Lond., XIX, 86–87, fig. 8 on p. 84.

Eurypterus ? (*Euphoberia*) *ferox* (pars) Woodward, Geol. Mag., X, 109, fig. 8 on p. 105. — *Ib.*, Mongr. Merost., 172, fig. 62 (1872).

Half a dozen segments of the body, seen from above, are all that are preserved of the single known specimen of this animal. The body is equal throughout, but is perhaps broader than high, subcylindrical according to Salter, the surface rugose. Each of the segments is

divided into an anterior and posterior portion, the former apparently elevated, spiniferous, occupying from two-thirds to three-fourths of the entire segment, which as a whole is scarcely twice as broad as long. The four rows of spines are represented as if at about equal distances apart, those of the subdorsal row indicated only by their bases; those of the lateral row appear from the figures given to be almost a mere lateral expansion of the edge of the dorsal plate, apparently depressed, forming a laminate compound spine, consisting of a main flange, two-thirds as long as the width of the segment, broad at base and bearing there a triangular, anterior, pointed spinule of considerable size, beyond narrowing and tapering and at the same time curving a little backward to a sharp point, bearing however midway a triangular pointed spinule, very broad at base and nearly as conspicuous as the main spine itself; so that it might be said to be apically forked as in the preceding genus. Salter says that these lateral spines "have at their base, front and back, two other smaller spines," but only an anterior one is figured. "The length of the fragment, including five rings" — the sixth is detached — "is 1½ inch; and the breadth of the axis, without the long forked spines is ⅔ths inch. The forked spines are ⅔ths of an inch each."

Locality: North Straffordshire, in ironstone.

This specimen was considered by Salter as "the central lobe of the abdomen of a trilobate Eurypterus or allied genus," and like Westwood in speaking of the last species, he says "it would strike an entomologist as a fossil caterpillar of the Saturnia genus, so strong is its resemblance in size, form and ornament to the larvae of that group." It differs from the other species of Euphoberia in its size, its remarkably depressed spines with very large spinules both at base and in the middle, and appears in these two points to approach Acantherpestes, on which account we have placed it nearest them in this list; its subdorsal spines could hardly have been of the same character as these lateral spines in every respect; and if they did not, this would prove an additional distinction from the other species.

Euphoberia horrida, nov. sp.

Pl. 10, figs. 11, 12, 14.

Messrs. Armstrong and Carr have each sent me a specimen and reverse of an unusually large species of Euphoberia, with highly developed spines, to which the above name may be given. Mr. Carr's specimen (fig. 11). is the better preserved and the more perfect. It apparently represents nearly the entire animal lying partly upon its side, so as to throw the legs upon one side and the subdorsal spines upon the other, but exposing part of the dorsal surface also; toward the hinder extremity the legs appear on both sides; the body lies in a rather strongly sinuous curve, the two extremities broken off, each probably close to the tip, at the edge of the nodule. As it lies it is 107 mm. and if extended would be 119 mm. long, so that its total length must have been at least 130 mm; its width anteriorly is 8 mm.; at the greatest 4.5 mm; at the posterior extremity 10 mm.

About twenty-eight segments are preserved, and there may not have been more than three or four and probably were not over five or six more. The first five or six segments preserved are of equal size, then the body enlarges a little for six or seven more, then diminishes again, and continues to do so with considerable regularity to the hinder

extremity, which is hardly more than half as broad as the front extremity, and a little less than half as broad as the middle of the body. The swollen portion of the body is therefore unusually distant from the head. In several places near the middle and at the anterior extremity of the body the original texture of the dorsal plates seems to be preserved (fig. 14), showing that the surface was covered with minute and rather sharply elevated circular papillae, about 0.035 mm. in diameter and pretty uniformly distributed at distances averaging about 0.1 mm. apart; otherwise it appears to be smooth; but the surface of the ventral plates is very finely and transversely striate.

The junction of the dorsal and ventral plates can be seen high up upon the sides of the body as it lies, as represented in figure 11, the line of separation being a straight one. The segments, as represented by the dorsal plates, are about twice as broad as long in the middle of the body, which has the appearance of being somewhat contracted and thus shortening the segments, but in front and behind they are proportionally longer, being less than half as broad again as long. The dorsal plates are divided transversely into two equal portions, the front portion being elevated, selliform and spiniferous, the hinder half depressed and nearly flat.

The spines of only one series, apparently the subdorsal, are preserved, but in this throughout nearly the whole length of the body; each is situated on a somewhat elevated boss which merges into the spine, but at base is as broad as the entire front half of the dorsal plate and develops anteriorly the main spine, a stout, cylindrical, erect, straight stem, slightly inclined backward, which in its middle divides into two portions, a comparatively small, short, conical, pointed thorn, continuing very nearly the erect line of the main stem but inclined slightly forward, and a similar but very long and slender pointed thorn, as long as or even longer than the main stem, directed backward at a considerable angle and also slightly curved in the same sense, so as to make the entire spine about half as long as the width of the body in the broadest portion of the same, or about two-thirds its width in the other portions. In addition to this forking of the main stem, the boss expands at its posterior extremity, at the hinder lower elevation of the selliform dorsal plate, and bears the spinules which in other species seem to cluster more strongly to the very base of the main stem of the spine; these spinules are two in number, straight, vertical or inclined backward a little, the anterior much longer than the posterior, both slender, nearly equal, tapering only next the pointed tip, arising from a very short main stem which is even stouter than the main stem of the spine proper, the tip of the longer spinule reaching about as high above the body as the fork of the main spine.

The legs are preserved throughout the greater part of the fragment, but so indistinctly that in no case can the joints be determined with any precision; they appear in general to be divided much as in *Acantherpestes major*, but they are proportionally slenderer than there, as is the case with all other species of Euphoberia; they are slightly shorter than the width of the body excepting near the slender hinder extremity, where they do not diminish in size and length so rapidly as the segments, and are therefore proportionally to the width of the body longer than elsewhere; they appear, as in *Acantherpestes major*, to have a median carina, to taper gradually, especially in the apical third and to be either bluntly pointed at the tip, or, in other places, rounded. The legs are

about 7 mm. long in the front part of the body, 9 mm. in the middle and 5.5 mm. at the posterior extremity. The spines are about 5 mm. long.

Mr. Armstrong's specimen represents nearly as large an individual as the preceding, but it is not so well preserved, nor is the fragment so great, being composed of thirteen or fourteen segments besides the head, and exhibiting a dorsal view, but with some of the ventral plates exposed. The fragment is 72 mm. long, stretched in a straight line, 8.5 mm. broad in the broadest part (near the middle of the fragment), from either side of which it diminishes regularly and very slightly so as to be about 6 mm. broad at the segment behind the head, and 7.5 mm. broad at the end of the fragment; it is largest and about equally large from the fourth to the eleventh segment behind the head. The spines, the lateral rows of which are exposed along either side of the body, are exactly similar in structure in every particular to those of the preceding specimen, but are a little longer in proportion to the width of the body than there, being 6 mm. long where the width of the body is a little more than 8 mm. Signs of the position of some of the closely approximated subdorsal series may also be seen. Excepting at the hindmost end of the fragment, the segments are everywhere scarcely half as broad again as their length. No legs are visible, but on one side of the fourth (or fifth?) segment behind the head is a straight, equal, apically pointed, compressed, unjointed rod, carinate along the middle, as stout as the stem of the spines, nearly three-fourths as long as the width of the segment on which it is seated, and projecting from it at right angles (fig. 12). Probably, as in other cases to be given in other species, it is the intromittent organ; it is 5.75 mm. long and 0.6 mm. broad; as the first segment preserved is not unquestionably the head, the segment on which the rod is situated is of course uncertain; the reasons for supposing it to be the head are that the body appears to terminate there, just before the edge of the stone, and that the segment itself, while bearing no appendages, is, as is the case with the head in specimens of other species of Euphoberia, more deeply impressed and extends further on one side than on the other of the fossil. No characteristics beyond this can be made out.

This species differs from the other of the genus in its greater size, and from the next, to which it is most nearly allied, in its proportionally longer segments and in the more extended development of the basal posterior spinules of the spines of the body, which in this species are more widely separated from the main stem than usual.

Euphoberia armigera Meek and Worthen.

Pl. 9, figs. 1, 2, 3, 5, 6, 13; — pl. 10, figs. 7, 8, 10.

Euphoberia armigera Meek and Worthen, Amer. Journ. Sc. Arts, (2), XLVI, 25-26 (1868); — *Ib.*, Geol. Surv. Ill., III, 556-558 (pars), figs. C, D on p. 556 (1868); — Woodward, Geol. Mag., VIII, 103-104, pl. 3, fig. 7, (1871).

To this species I refer two specimens and reverses received from Mr. Carr, two others with reverses from Mr. Armstrong, another with reverse from Mr. Bliss, another, also with its reverse, from Mr. Worthen, a fragment sent by Mr. Pike, and the two figures C and D of Meek and Worthen's illustration, though it is possible that fig. C may be distinct.

The specimen figured in the Illinois report under the letter D, here reproduced in figure 6, by favor of Mr. Worthen, and which is copied by Woodward as above referred to, exhibits an inferior side view of the entire animal extended in a straight line. From this it seems that the tapering form of the creature does not appear on a side view, and it is even drawn as enlarging toward the head, which is considerably larger than any other part of the animal; toward the hinder extremity, however, it tapers gently; "the entire length is 3.9 inches and its breadth about 0.2 inch." The head is "semicircular, as wide as any part of the long slender body. It is not in a condition to show the eyes, nor are any remains of mandibles, antennae or other appendages preserved." It is represented as less than twice as broad as long. The segments are apparently nearly forty in number besides the head; of the ventral plates "as many as about seventy-five or seventy-six may be counted." The segments themselves are represented as only slightly and uniformly arched on a side view, and appear to be scarcely more than twice as broad as long. According to the authors, the surface of all their specimens, this included, show "a minutely granular appearance," but they figure only that of one of the others, with which I have a specimen agreeing, which seems to belong certainly to a distinct species, much more granular than those I would refer to this, and I therefore doubt whether the same description should apply to all of Meek and Worthen's specimens. The spines are all represented in dotted lines and it is impossible to say how much of them is intended to represent what can be seen on the specimen. They are represented on every segment behind the head. The legs are also mostly given in dotted lines, there being only one exception, where it is given fully as long as the width of the body and composed of four equal joints: the text, which refers to them all, says "five gradually tapering joints." On the ventral plates little round openings are marked a little above the bases of all the legs, and above them smaller dots; the former, say the authors, may be the point of attachment of the legs; the others they compare to spiracles.

Fig. 6. *Euphoberia armigera*; figure D of Meek and Worthen.

The second specimen figured by Meek and Worthen, marked C on p. 556, and reproduced here in fig. 7, is the posterior portion of a similar animal, presenting the same view as the last mentioned, but bent abruptly downward at the posterior end; it is much more tapering at the hinder end than at the other, being at this part only a little more than half as large as the broken anterior end; although imperfect, it is larger than the other and nearly as long. It has twenty-three segments, which are uniformly arched on a side view, and not more than twice as broad as long. The same statement concerning the surface sculpture may be made of it as of the other specimen. The spines, many of which of the subdorsal (?) series are represented, are rather short and stout, generally less than half as long as the width of the body, but as they appear to originate on its

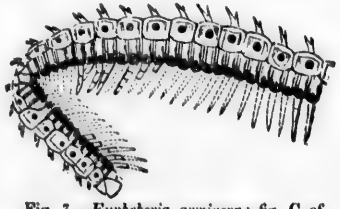

Fig. 7. *Euphoberia armigera*; fig. C of Meek and Worthen.

further side their bases may not show, in which case they are longer; they are tapering and sharply pointed and bear anteriorly, not far before the tip, a small, delicate, pointed spinule; they are represented on every segment but the last. The legs which the text describes (for all the specimens) as five-jointed are three- or four-jointed in all figured, the joints of equal length, the whole leg moderately stout, tapering, and slightly longer than the width of the body. Similar circular holes are shown above the bases of the legs on each of the ventral plates, as in the last specimen mentioned, and like them probably represent the bases of the nearer pair of legs, all of which are wanting.

This specimen differs from the last mentioned in the greater length of the dorsal plates, and in a more conspicuous tapering of the body posteriorly on a similar view; but it probably should be considered as of the same species.

The third specimen which I would refer here is one which I have received from Mr. Carr, and first saw through the kindness of Mr. Pike (Pl. 9, fig. 1). It lies flat upon its back, with the lateral spines projecting equally on either side; a fragment on a higher level at one side shows a few legs, proving that we have here the inner view of the dorsal plates. It is nearly straight and nearly or quite complete. It has the appearance of being unnaturally flattened so as to preserve slight indication of its probably nearly cylindrical form, but its position gives the best view of the form of the animal; it is largest at the end of the first third of the body or from the twelfth to the eighteenth segments; in front of this it tapers very gradually and regularly, so as to be about one fifth smaller just behind the head, while the head itself, as in the first specimen mentioned, is again broader; posteriorly it gradually tapers more until the hinder fourth is reached; this is of nearly uniform width and a little less than one-third smaller than the broadest part; in the form of the front of the body therefore it more nearly resembles the first specimen mentioned (D, fig. 6, supra), while in that of the posterior extremity it is like the second specimen (C, fig. 7, supra); the length of the animal is 105 mm.

As to the head (Pl. 9, fig. 3), it is rounded in front and very short, being much shorter than the body segments and as broad as they, but even broader than those nearest to it; it bears posteriorly a narrow, prominent, transverse ridge which appears to bear on the left side the scar of a subdorsal spine, but situated, like that of the next segment, far toward the side of the body; something which looks like a spine, but which may be an antenna, projects forward and outward from the outer front angle of the head; it is straight, tapering, rather regular and bluntly pointed, as long as the depth of the head; no joints can be seen in it. The segment immediately behind the head is very pinched, not half so long as the head, and bears lateral as well as subdorsal spines; the lateral spine is not represented on the enlarged drawing of this part. The other segments are similar to one another and number thirty-seven, including all but the head; probably they include the whole animal, although the hinder edge of the creature is broken, and there may be one or two more segments; this number it will be noticed agrees very closely with that of the first perfect specimen mentioned. The average length of the body segments is nearly 3 mm. while the average breadth is about 5.5 mm., the segments being about twice as broad as long, in which it agrees again very well with the other specimens described; this proportion holds well throughout the body, the broadest segments measuring about 7 mm. and their length about 3.5 mm.; while at the tail where the width is 4 mm.

the length is barely 2 mm. The segments although much flattened in preservation show, particularly in the larger parts of the body, distinct signs of having been ridged on the anterior half which bears the spines, a feature not seen, where we should the more expect it, in the figures given of the lateral views of the two other specimens.

The head is delicately granulated, the granules oblong with their longer axes longitudinal, and showing a tendency to run together in wavy but generally straight longitudinal ridges; these markings however are rather faint and dull; similar granulation appears obscurely in one or two of the segments behind the head, but shows no tendency to a longitudinal arrangement. The same circular disks which were described in the large specimen of *Acantherpestes major* appear here also all over the body, but the material of which they are formed has generally cracked extensively in an irregular manner, so that they are not so conspicuous; those of average size have a diameter of about 0.35 mm.

The subdorsal row of spines appears only by the little pits upon the surface, which show that these rows are placed a little nearer together than either of them to the lateral rows. The spines (Pl. 9, fig. 2) are preserved in the lateral rows on one side nearly throughout the body, on the other in the anterior third; in their length they show a constant relation to the size of the segments, and are present on all the segments behind the head, excepting near the tail where they are lost. They are more than half as long as the segments on which they occur, very broad at base, rapidly narrowing at first, especially on the hinder edge, and then taper gently, with a slight backward curve, to a delicate pointed tip; they are not compressed or depressed but circular in cross section, and bear at the base posteriorly (only seen in this specimen on one side of the body) a posterior, basal, triangular thorn directed backward and outward; it is stout, conical, pointed and nearly half as long as the segments; its absence from the spines of the right side is due no doubt to the position of these spines, and the spinules might be found attached also to them by cutting the stone; besides this basal posterior thorn, there is an anterior delicate spinule on the middle of the spine plainly visible, at the base of which the spine has a slight bend backward in most cases; this is not shown in the one selected for enlargement (Pl. 9, fig. 2), nor is it brought out in the drawing of the natural size; from certain appearances it looks as if there were, at the point where this anterior spinule arises, not merely this one spinule, but a circlet of them, three or, counting the extremity of the spine as one, four in number: one anterior as described, minute, pointed, hardly directed forward; the posterior or spine proper, which is nearly as long as the basal part of the spine, tapering regularly and pointed, directed only a little backward, divergent from the first at an angle of about 45°, and occasionally very slightly curved backward; still another superior (or interior) one is indicated by a slight mark, seen in the enlarged drawing as a dark spot at the base of the anterior spinule, indicating the base of a spinule; and possibly, to match it, one on the opposite side, of which of course no indication could well appear.

The only appearance of legs is in a short fragment at the middle of one side which slopes down toward the body, where three sets of two each appear; they are of equal length, and therefore are probably complete, for the stone is not split on a different plane from that in which they lie until some distance beyond their extremities; they are therefore very much shorter than in *Acantherpestes major* and considerably shorter than the width of the body; the first joint appears to be broken off at the edge of the stone; the second

is equal in length to the remainder of the leg (though this point is obscure and doubtful), slender and compressed, with only a faint sign in one of any carina, equal in width throughout, and about six or seven times as long as broad; the rest of the leg tapers to a bluntly rounded point, with no possibility of making out distinct joints from the obscurity of its preservation; on two, a tapering, curved claw appears to be present, not sharply pointed, less than 0.5 mm. long; the entire leg is 5 mm. long and its greatest breadth 0.4 mm.

The next specimen referred here, and which was received from Mr. Worthen (Pl. 9, fig. 6), presents a nearly straight and uniform ventral view. There is no apparent sign of tapering toward the head, the anterior half being nearly uniform in size; behind this it tapers gradually and uniformly, so that the hinder end is about two-thirds the width of the anterior half. The length of the creature is 98 mm., its greatest breadth 6 mm., narrowing to 4 mm. at the tail. The head and first segment (Pl. 9, fig. 5) are together represented by a deep and large, well rounded depression, in the intaglio half, as broad as the segments behind it, and together much more than equalling two of them; the head would appear to have been much broader than deep and higher than broad, drooping and passing below to a lower plane than the rest of the body, and with the next segment forming a compact globe; next the lower front edge of this globe is a slight rounded depression (indicating a slight boss in the living creature), on which are half a dozen ovate wartlets or granules which may indicate the eye, but it is too vague for any assertion.

The segments are many of them obscure, but appear at first sight very numerous, numbering some sixty or seventy, but as these are the ventral plates the real number is only half of this; the whole body is blurred in parts, rendering it difficult or impossible to be more precise; these ventral plates average 1.5 mm. in length, and where they are distinct, as in the broadest part, they are four times as broad as long; they are well arched transversely, indicating a well rounded body, and have their anterior half stoutly ridged. They show in places series of short, longitudinal, slightly oblique, slight and irregular corrugations. Traces of the insertions of the legs can be seen on many segments, situated in the centre of the front margin of the depressed portions; above them (that is, toward the spined margin) there is a slight trace here and there of stigmata, but I have not been able, so poorly preserved is the fossil, to detect any of the crateriform branchial cups, described in *Acantherpestes major*. The subdorsal spines of a single row are present on many of the segments, but poorly preserved, and are small, being only about one-third the length of the width of the segment on which they occur, rather stout at base, beyond this tapering, and curving slightly backward, and at first sight apparently simple; one, however, faintly shows a part beyond the apparent tip, indicating that the others have been broken; and as this is provided also with a slight anterior spinule in the middle, and a basal posterior thorn, it agrees entirely with the last specimen described. There are a couple of fragments of legs just beneath the junction of the first and second ventral plates behind the head, situated side by side and touching; they apparently represent the basal joints. We have here new proof that the first segment, represented by one dorsal plate behind the head, bore two pair of legs in these myriapods, and the additional evidence derived from the presence of the complete ventral segments to which they were attached. There is besides only a single indication of what may be a leg, which appears at about the eighth ventral plate behind the head, on the side opposite to that to which the

spines are attached (Pl. 9, fig. 5); it appears as a straight, cylindrical, slightly tapering, unjointed rod, 4 mm. long, 0.3 mm. broad, the segment from which it springs being 5.3 mm. broad; it has the appearance of a spine, but is altogether unlike any of the other spines and probably represents the intromittent organ.

The next specimen to be discussed is a fragment received from Mr. Pike after this paper was written, and is introduced here with a figure (Pl. 10, fig. 8) of a portion of it, because it exhibits certain features of the ventral portions seen on no other examined. It represents the posterior half, more or less, of a myriapod, extended in a slight sinuous curve, the legs trailing beneath, and a few spines showing above. The length of the fragment is 47 mm., its breadth in front 4 mm., and beyond the middle of its posterior half 1.9 mm.; beyond this it is very obscure, but between these two points it seems to taper regularly. From twenty-one to twenty-three segments are preserved. The jointing of the legs is very obscure but appears to be as in the figure, the basal joint seen, undoubtedly the second, being about as long as the rest of the leg; the legs are about as long as the width of the body, slender and tapering. The subdorsal series of spines, the only ones preserved, are rather small, and show only here and there, and obscurely, any subsidiary spinules. What, however, is of the chief interest is the preservation of the ventral plates in an unusual manner; these are separated from the dorsal plates by a straight line along the middle of the body, and appear to be four in number to each dorsal plate; in reality there are two, each being again divided into a pair of subsegments by a transverse line just behind the middle and only a little more faintly incised than the lines of demarkation between the plates; the appendages are borne only by the anterior, larger, subsegment; these are, so far as can be seen, the legs, which are attached at the extreme base in circular pits; and just above them the spiracles, slender, ovate in form, their longer diameters nearly as great as the diameter of the leg-pit and placed a little obliquely but nearly transverse to the body, the upper end furthest back, thus differing from Acantherpestes only by their slight obliquity. The sight of this specimen inclines me therefore to believe Meek and Worthen to have been correct in referring the openings above the leg attachments (see fig. 6, supra) to spiracles, which they speak of as less rounded than the pits supposed to be the points of attachment of the legs to the body. A similar division of the ventral plates into subequal anterior and posterior portions is evident in other species of Euphoberia, as may be seen from the plates.

Mr. Bliss sends an interesting specimen not very well preserved, indeed, but showing some valuable features of the head (Pl. 10, fig 7). It represents about twenty segments of the body besides the head, lying flat in a straight line, with the lateral rows of spines projecting equally on either side. There are two peculiarities in it which seem to make it a little doubtful whether it should be referred to any of the species of Euphoberia here described: first, the segments are extremely crowded and very short compared to their breadth, varying from two and a half to three times as broad as long; second, the portion of the body exposed, though very favorably displayed for exhibiting any such feature, shows scarcely any enlargement of any region of the body; it does indeed taper slightly from about the eighth segment forward, but so slightly as hardly to be noticed without direct observation; the margins of the body are, however, poorly preserved and may give it a deceptive appearance; it differs slightly also from other specimens of this species in the brevity of

the spines, which are less than half as long as the width of the body. From the character of the spines, however, the surface character and general appearance of the segments, and the size of the body, it can hardly be doubted that it belongs to this species. No legs are present, but there are two features worthy of note: first, on one side of the fourth segment behind the head protrudes a pair of straight, attingent, tapering, bluntly-tipped, so far as can be seen unjointed rods, directed at right angles to the body and inclined a little forward, half as long as the width of the fourth segment, and each considerably stouter than the spines; they certainly may be legs though they differ somewhat from them; but appearing at this place only and recalling similar organs in other specimens of Euphoberia, one cannot help inclining to believe them to represent intromittent organs, and this specimen has then a special interest from being the only one yet found in which a pair is preserved; second, the appendages of the head; the head is considerably broader than the body, scarcely longer than the body segments, broadly and very regularly rounded in front; from either side of the front, about midway between the middle and the outer margin, springs an antenna, composed of four joints: the first, of which only the apical part can be seen and that obscurely, seems to be small and cylindrical; the second, also obscure, is large, stout, cylindrical, perhaps enlarging apically, a little longer than broad, terminating bluntly; the third about as long as the second but very much slenderer, cylindrical, enlarging a little apically, terminating bluntly and followed by an ovate terminal joint, twice as long as broad and a little narrower than the apex of the penultimate joint.

The length of the fragment is 54 mm.; probably not more than half of the whole is preserved; its greatest breadth is 7.5 mm. and just behind the head 6 mm.; the head is 9.5 mm. broad and 3 mm. long; the whole antenna 3.3 mm. long; second joint 1 mm.; third joint 0.9 mm.; fourth joint 0.45 mm.; greatest width of second joint 0.5 mm.; third joint 0.55 mm.; fourth joint 0.38 mm.

Another specimen, and part of its reverse sent by Mr. Carr represent the larger part of a curved body on a lateral view with a few spines and many legs, none of it very well preserved; the head is not reached anteriorly although very few segments behind the head can be missing. Nearly thirty segments are present, representing a large animal, 115 mm. long so far as preserved. The only parts worthy of special mention are the legs, which are in some places very well preserved; they are very nearly as long as the width of the body; the first and second segments are of equal width with parallel sides, but beyond this the leg tapers to a point; the second joint is much longer than the others, longer indeed than the third, fourth and fifth together; the first and third are of equal length and a little longer than the fourth, fifth and sixth, which are of similar length; the first joint is nearly twice as long as broad, the second nearly six times as long as broad, the third twice as long as broad. The legs therefore essentially resemble those of *Acantherpestes major*, differing from them only in detail; the specimen figured (Pl. 10, fig. 10) shows no sign of any median carina, which is visible on some of the legs and not on others. The leg measures 7.25 mm. in total length, the first joint being 1.4 mm. long, the second 2.75 mm., the third 1.3 mm., the fourth and fifth each 0.9 mm.; the last 1 mm.; the width of the second joint is scarcely more than 0.5 mm.

The specimen received from Mr. Armstrong is very imperfect and adds nothing to our knowledge of the species. It is a nearly entire body of a small animal preserved on a side

view, with both ends drooping but neither perfect, none of the spines and only a few of the legs partially preserved. The length of the fragment as it lies is 33 mm.; if extended it would probably reach 38 mm., and represent the full length, nearly thirty segments being partially or wholly visible.

All the specimens which I refer to this species come from the carboniferous ironstone nodules of Mazon Creek, Morris, Ill. Those which have been personally examined were received from Messrs. Carr, Armstrong, Worthen, Bliss and Pike.

The species differs from the last mentioned in the somewhat shorter segments and less highly developed spines; it is besides somewhat smaller; the spines are longer than in the American species hereinafter mentioned and the shape of the body also differs.

The Scotch *E. Brownii* is not improbably distinct from this, but is said to have no spines preserved, removing one of the best sources of comparison; this, judging from the cast I have, seems to be a mistake, the appendages on the concave side of the body having the appearance of being spines, while those of the convex side are certainly legs. If those of both sides are really legs it presents a dorsal (or a ventral) aspect, and must be considered as distinct from this species because it does not taper to any considerable extent. If it presents, as is far more probable, a side view, like those of the specimens of the present species figured by Meek and Worthen, the spines must be incorrectly drawn in Woodward's figure; on the cast they appear much stouter than the legs (of the convex side), and appear to be of about the same size as in the present species, but with no basal thorn, or none of any size.

Euphoberia Brownii Woodward.

Pl. 9, figs. 7, 8, 21.

Euphoberia Brownii Woodward, Geol. Mag., VIII, 102-104, pl. 3, figs. 6 *a.-c.* (1871).

The single specimen upon which this species was based, gives, according to Woodward a dorsal view of the animal in a slightly curved position; but judging from a cast which I owe to his kindness, as well as from the features of the animal as figured by him, we must adopt the view that it presents a lateral aspect. Below, *i. e.* on the convex side, the appendages (legs) are really much longer than those (spines) upon the opposite side, though similarly figured by him, even in an enlarged view (pl. 9, fig. 7, 8); and at this same margin, as in figures C and D of Meek and Worthen's *E. armigera*, though not to so great an extent, the pair of ventral plates can be seen against the lower edges of the dorsal plates; and on the posteror part of the body, from which Woodward's figure 6^b (pl. 9, fig. 7) is probably taken, only the lateral row of spine-bases can be seen. The body is flattened and of very nearly uniform size throughout, a little the largest near the seventh segment and a little tapering posteriorly; this form would also indicate a lateral view. The body is 90 mm. long and 6.5 mm. broad at greatest. The head is rather broader than the segments behind it, scarcely more than half as long as they, and well rounded, with a constriction in the middle, giving it the appearance of being formed of two rounded lobes. No appendages can be seen. The segments are stated by Woodward to be thirty-six in number besides the head. They are composed of two equal parts, the anterior forming an

arched transverse ridge, undoubtedly that bearing the spines, the posterior flat; as a whole, the segments are about twice as long as broad; nothing is said by Woodward about the surface sculpture. Of the spines Woodward says "there are indications of pores and also of tubercles or spines along the dorsal line, but the latter less perfectly preserved." His enlarged drawing (Pl. 9, fig. 7), shows a single row of marks of spine insertions (?) along the middle line of the body, on the *depressed* portion. To judge from the cast, they seem to be arranged in distant subdorsal and lateral rows, and those of the subdorsal row, as seen beyond the body, to be mammiform at base, beyond tapering, curved, pointed, and as long as the segments, apparently simple, and originating from the *arched* part of the segments; the pits figured by Woodward should probably originate from the other half of the segments and represent the lateral rows. The legs (Pl. 9, fig. 8) are represented as being as long as the width of the body and as composed of three joints, the first and last of equal length and the second as long as the others together; this can hardly be correct.

The only American species with which this can be compared is the one to which Meek and Worthen's name of *E. armigera* is here retained. I have given under that species the reasons for believing that it is distinct, but this cannot be considered as conclusive until a further study of the Scotch specimen is undertaken.

The specimen was found in a nodule of clay ironstone from Kilimaurs, Scotland, by Mr. Thomas Brown.

Euphoberia granosa, nov. sp.

Pl. 9, figs. 22, 24, 25, 26; pl. 10, fig. 13.

Euphoberia armigera Meek and Worthen, Amer. Journ. Sc. Arts, [2], XLVI, p. 25-26 (pars) (1868).—*Ib.*, Geol. Surv. Ill., III, 556-558 (pars), figs. A. B. on p. 556 (1868).—Roemer Leth. geogn., pl. 47, fig. 19 (1876).

The study of the series of specimens that have been intrusted to me, and of the figures and descriptions given by Meek and Worthen, lead me to separate one (A) of those figured by them as distinct from the others, and to place with it some others, for the opportunity of examining which I am indebted to Messrs Worthen, Carr and Armstrong.

The specimen figured in the Illinois report, and which is reproduced in the accompanying wood cut kindly furnished by Mr. Worthen, presents a dorsal view, with a trace also of the ventral plates of one side of the body in a curved position, neither end preserved, and showing spines upon one side and legs on the other. The body is of nearly uniform size throughout, but tapers a very little posteriorly. It is not so large as any of the previously mentioned species, the fragment being about 54 mm. long, and averaging about 5 mm. broad. The segments preserved are twenty-three in number, each nearly three times as broad as long, the anterior portion transversely ridged and bearing the spines of both rows, and the narrower posterior portion depressed. The description of the surface sculpture given by Messrs. Meek and Worthen for their species *E. armigera* seems to me to apply only to this specimen, which they have chosen to represent it (in fig. B); they say "Under a magnifier, the surface . . shows a minutely granular appearance . . . ; as these granules are seen on the surface of moulds or impressions left in the matrix, they indicate the presence of a minutely pitted marking on the fossil itself." The subdorsal series of spines, as indicated by the pits on the surface of the

Fig. 8. *Euphoberia granosa.*

body are distant from each other, and probably quite as near the lateral rows as they are to each other; the spines of the subdorsal rows, which only are preserved in their entirety, are less than half as long as the breadth of the body, stout, conical, curving backward, finely pointed, and bear near the middle a delicate anterior spinule. The legs are represented as tolerably stout, a little longer than the width of the segments and composed of five equal joints.

The first of the specimens I have seen which I refer to this species, and in which we have both obverse and reverse (Pl. 9, figs. 22, 25, 26), was received from Mr. Worthen, and shows a partly dorsal partly lateral view of most of the body, the head end missing, curving upward near the middle so as to be bent nearly at right angles. The anterior half of the fragment is uniform in width; behind, it tapers slightly and regularly, so that the posterior end is about two thirds as broad as the stoutest portion. The entire length of the fragment is 60 mm. and its greatest width 4.25 mm. There are twenty-seven segments preserved, varying from 2 mm. to 2.5 mm. in length, *i.e.* they are about twice as broad as long, or somewhat broader than that; transversely they are not very strongly arched, indicating a somewhat flattened body; longitudinally they are very strongly divided into two parts, the anterior two-thirds being very much elevated, ridged and spiniferous, the posterior third deeply sunken; between the subdorsal spines is a slight, dull, transverse furrow. Over all the segments may be noticed distinct, close granulations, a little coarser on the lower non-spiniferous parts of the segments, and more apparent in the front than in the hinder portions of the body; they appear in the cast of the upper surface and therefore indicate, as Meek and Worthen say, a pitting of the exterior crust (Pl. 9, fig. 24).

The spines of the lateral rows are far down the sides of the body, while the subdorsal rows approach them, being set very widely apart; those only of the lateral rows are preserved (Pl. 9, fig. 24), and are rather more than half as long as the width of the body, tolerably stout, tapering, curved slightly backward, and not very sharply pointed; they have a slight anterior spinule springing from the extreme base. The legs are present along the whole under surface, which is so preserved as to show well the basal joints; these are not so stout, comparatively speaking, as in *Acantherpestes major*, and taper a little, the adjoining legs not touching each other at base but separated by a considerable space; the basal joint is evidently compressed, subquadrate, with a not very pronounced median carina, terminating squarely, a little longer than the basal breadth, and about 1.1 mm. long; the second joint is long and slender, nearly as broad as the tip of the first and about six times as long as broad; it is laminate, straight and equal, with a median carina of no very great prominence; its length is about 2 mm. and its breadth 0.32 mm; a third joint is sometimes visible and is slightly narrower, and only a little longer than broad, quadrate, appearing as a mere continuation of the second; all the parts beyond are broken off in all the legs, the longest of which is 4 mm. where the body is of the same width.

A second specimen belonging to the collection of Mr. Carr (Pl. 10, fig. 13) exhibits on one stone the entire length of the animal, and on the counterpart almost the whole. It lies in a nearly straight line upon its side, showing the spines on one side and the legs on the other, somewhat faintly and imperfectly, but throughout nearly the entire extent of the body. There are nearly forty segments besides the head, but the exact number cannot be determined from the obscurity of some parts. The length as preserved is 63.5 mm. which, if

extended, would be about 70 mm.; it is of a nearly uniform width of 3.1 mm. throughout, but tapers posteriorly especially on the apical fourth, so that the hinder extremity is only 2 mm. broad; at its broadest part it measures 3.3 mm.; perhaps by its mode of preservation it does not show the entire breadth, for the legs, which in other specimens of the species are no longer than the body, are here 3.75 mm. long. The spines agree in character with those of the last specimen mentioned, but in only one or two places can the anterior spinule be recognized. The segments of the body are very badly preserved and are hardly twice as broad as long; the structure of the surface can nowhere be distinguished, but some signs exist of the marked distinction between the anterior and posterior portions of the segments; the head again is badly preserved; it is very full in front, and bears a distinct, long and slender antenna, as long as the depth of the head, originating, on a side view, above the middle of the head, and consisting of seven subequal joints; the first and second are slightly longer than broad, rounded subquadrate, a little larger at the tip than at base; the fifth and sixth similar but smaller, the last similar but much smaller, and the third and fourth like the basal ones, but longer and more cylindrical, perhaps a little more than half as long again, or twice as long as broad. The whole antenna is 3 mm. long and in the middle 0.3 mm. broad.

Three specimens of this species, two of them with counterparts, are found in Mr. Armstrong's collection; one of them with its counterpart shows twenty-three segments of the posterior portion of the body lying in a nearly straight line, partly on its side, with spines on one side and legs on the other. The total length is 60 mm. and the broadest part 4.5 mm. wide, a width which is retained with slight diminution until the last 20 or 25 mm. are reached, when the body tapers more rapidly, and just before the tip is reduced to 3.25 mm. As in the last specimen, the anterior basal spinule of the spines is rarely visible, and the spines themselves are unusually slender and pointed, and rather more than half as long as the width of the body. The legs are slightly shorter than the width of the body, and the segments, which are much flattened, and poorly preserved, show signs of the granulation of the surface and the difference of level of the anterior and posterior portions which is characteristic of the species.

The other two specimens referred to this species are very imperfect and add nothing to the points already brought forward.

This species differs from all the others in the coarser pitting of the surface and in the deep and sudden contrast in elevation between subsegments. The segments are also much longer than those of the preceding species, the legs longer than usual and the spines rather shorter, although of the same simple character. The subdorsal spines are separated at an unusual distance, and there is a transverse sulcation between them, in which points it differs markedly from those of all the other species; it seems apparent, therefore, that it cannot be confounded with the other specimens referred by Meek and Worthen to their original *E. armigera*. This specie also shows scarcely any sign of tapering, excepting toward the hinder extremity and here very gradually; in this respect it presents features very different from the following species. All the specimens known came from Mazon Creek.

Euphoberia Carri, nov. sp.

Pl. 9, figs. 4, 9-12, 14-19; pl. 10, figs. 10, 18.

Five specimens, all showing relief and intaglio, are preserved. The first (Pl. 9, fig. 16), is bent into the shape of an L and presents on the longer anterior limb a dorsal view, but the hinder portion is somewhat twisted as well as bent so as to be partly lateral; both extremities are broken off. The body thus preserved is largest anteriorly, nearly equal on the front half of the fragment; behind this it tapers at first considerably, afterward less rapidly, so that the posterior extremity is scarcely more than half as broad as the anterior portion; the body is very strongly flattened, but may have been rounded. The fragment is about 58 mm. long, 6.5 mm. broad in front and 3.5 mm. broad behind. There are twenty-four or twenty-five segments, about twice as broad as long; there is little sign of any ridging in the anterior part of the body, but toward the posterior part the spiniferous portion is clearly seen to be elevated above the plane of the remainder of the segment. The whole body is minutely and closely granulated like a very fine shagreen (Pl. 9, fig. 4, showing the first segment enlarged); there are also some slight signs of the same circular disks that have been described in other specimens, and which are of the same size as in *Acantherpestes major*.

The subdorsal spines are placed in contiguous rows, which are separated by a considerable space from the lateral row, where only are any preserved entire, and that only in a few places. They are of more uniform length than the width of the body (Pl. 9, figs. 17, 19), being about half as long as the width of the body where the latter is slender, and less than one-third as long in the anterior broader part; they are almost simple, being conical and sharply pointed beyond a more or less mammiform base, curving slightly backward, especially beyond a minute anterior thorn or spinule which springs from the end of the basal third, and is only slightly divergent from the main spine. The legs are preserved at only one part of the fossil, in the slenderer portion of the body; they appear (Pl. 9, fig. 18) to taper throughout and almost uniformly, or a little more rapidly on the apical than the basal half; there is plainly a median carina, and on some it even extends throughout the length of the leg, but it is impossible to tell where the joints are; the whole leg is 4.75 mm. long, where the width of the body is slightly less than that.

The second specimen (Pl. 9, figs 9, 12) probably presents the animal throughout its entire length, exhibiting a side view of the creature, doubled upon itself downwards in front of the middle, the front portion considerably curved and overlapping the other. The body tapers forward, but not very strongly, from about the seventh segment; the broadest part appears to have continued for about ten or twelve segments (the bend renders this uncertain) and then to have tapered rapidly, for the hinder third is uniform and nearly half as broad only as the broadest part; the body was plainly cylindrical, about 42 mm. long, 4.25 mm. broad at the broadest part and 2.5 mm. in the apical half.

The head (Pl. 9, figs. 14, 15) consists of a single segment considerably appressed, well rounded, not so long as the next segment behind it, but much deeper than it and drooping; what little can be seen of the surface is pitted and rugose; something which looks as if it might be an antenna droops from the upper anterior margin of the head, curved, tapering, and apparently rugose like the head, or else broken up into a great number of

joints; the whole is however very problematical. The segments are difficult to determine from the doubled position of the fossil, but there are apparently only twenty-eight of them; in all excepting the broadest part of the body they are twice as broad as long; there, they are a little more than twice as broad as long; the anterior half is transversely ridged and bears the spines, while the posterior half is flattened. The segments in the posterior portion of the body show a very faint, rather coarse and distant, scarcely noticeable granulation, but it is not elsewhere visible.

The subdorsal rows of spines are a little nearer to each other than either of them are to the lateral rows, as indicated by the pits; the only spines that remain are a few of the subdorsal series, near the front and again at the hinder end of the body, all of which are simple, straight, regularly conical, bluntly pointed, and directed backward; they have no subsidiary spinules, and are less than half as long as the width of the segments on which they are seated; a single one of the spines (Pl. 9, fig. 11) appears double and forked; it is probably due to the accidental presence of a broken spine. The spines originate near the front of the anterior ridged part of the segments. A few legs may be seen scattered along one side of the hinder portion of the body; none of them are perfect, and all that can be said of them is that they are slender (Pl. 9, fig. 10), flattened and tapering, with a median carina, at least on the basal portions; they are fully as long as the width of the segments to which they are attached; the longest fragments, apparently showing the tips in natural position, are 2.6 mm. long and 0.25 mm. broad, the segment to which they belong being 2.25 mm. broad. A few legs may be seen depending from the anterior part of the body (Pl. 9, figs. 14,15), and have special interest as certainly appendages of the first and second segments behind the head; one is attached to the hinder part the first segment, leaving ample room for another in front of it, and there is an obscure arance of the base of such a leg at its proper place, having the same form and general direction as the hinder one; in addition there is a third leg at the anterior edge of the second segment of exactly similar appearance; these legs are perhaps imperfect, but they are as long as the width of the segments at this point, compressed, tapering, straight and of moderate stoutness, with a slight indication of a median carina; joints cannot be made out; they are 3 mm. long and 0.5 mm broad at base.

The third specimen (Pl. 10, fig. 16) also represents the entire animal, bent in the middle and showing a partially side view, so that the legs appear on one side and the spines on the other. There are from thirty to forty segments besides the head, the exact number being indeterminable; the larger part of the body includes the first sixteen segments; with the seventeenth the body begins to taper considerably for several segments, and then narrows very gradually to the hinder extremity, which is only a very little more than half as broad as the broadest part; in the broadest part the segments are rather more, in the narrower part somewhat less, than twice as broad as long. The specimen is 48 mm. long, 3.25 mm. broad in front, and 2 mm. broad behind; in some places the surface appears to be closely and rather minutely granulated. The only spines preserved are some of those of the subdorsal row on the wider part of the body, where they are slender, conical, pointed, curved backward, as long as half the width of the body, generally furnished with a minute anterior spinule about the middle of the spine, which is directed upward or scarcely forward; the spinule is not half so long as the thickness of the middle of the spine, and is indeed

sometimes wanting. The legs are also preserved in the same part of the body and not elsewhere and are considerably shorter than the width of the body, being only from 2.25 to 2.5 mm. long, where the body is considerably broader. It should also be noted that the segment behind the head bears not only a spine but apparently at least one pair of legs, while on the second and each of the succeeding segments two pairs of legs are preserved.

But the greatest interest in this specimen is found in the head and its appendages. It is very short, with a well rounded front, and extends downward, as in the preceding specimen, considerably beyond the general lower line of the body. At its upper outer limit one sees a rounded oval space covered with a cluster of about a dozen large prominent hemispherical wartlets, each separated from the others by nearly its own diameter, and which together represent, apparently, the eye. It will be noticed that it appears on the upper part of the head and not, as in a specimen of *Acantherpestes major*, on the lower part. Projecting beyond the lower edge of the front is seen a long and slender jointed organ, which seems to be an antenna, agreeing in a general way with that found in *E. granosa*. It is about as long as the legs, nearly equal, perhaps a little larger in the middle than at the two ends, moniliform, composed of five subequal, broad, obpyriform joints, a little longer than broad, besides a much smaller, roundish oval, apical joint. The whole length of the antenna is 2.6 mm. and its middle width 0.3 mm. (Pl. 10, fig. 18.)

This specimen differs from all the others in the greater length and slenderness of the subdorsal spines, but agrees so well in its other characteristics that there are hardly valid grounds for its separation from them.

The fourth specimen is the largest of all though not very perfect; apparently the whole creature from head to tail is represented. It is 75 mm. long and appears to have about 33 or 34 segments besides the head, but some of the posterior segments are very obscure, making the exact number uncertain; the body tapers forward from about the fifth segment, but only slightly; back of this as far as the sixteenth segment or thereabouts, they are of nearly equal size, and then taper again a little more rapidly; but not so much so as usual in this species, although the hinder half of the body as a whole is only just half the breadth of the front part, the breadth in the front portion being 5.8 mm., in the middle of the hinder half 2.9 mm., at the hinder extremity 2.5 mm., and on the first segment behind the head 4.2 mm. The body is preserved on a dorsal view and the segments of the broader portion are a little more than twice as broad as long. The spines are very small, shaped as in the first specimen described, and not more than one-fourth as long as the width of the body in its broadest part. The legs are only to be seen in a few places; on the segments directly behind the head they are about three-fourths as long as the width of the segments, while near the middle and a little behind the middle of the body they are nearly as long as the width of the segment bearing them.

The head is about as long as the segments next it but much broader; indeed nearly twice as broad, being 7.5 mm. broad, with a well rounded front. No traces of any appendages can be seen. The second and third segments behind the head bear each two pair of legs, and the first segment a spine. This and all the specimens hitherto mentioned were received from Mr. Carr.

The last specimen to be mentioned (Pl. 10, fig 17), and which belongs to Mr. Armstrong, is a mere fragment of the head end of the body, showing about seven segments besides the

head, upon a side view. The fragment is 16 mm. long, somewhat curved, and shows spines upon one side and some legs upon the other. The spines are small and obscure, 1 mm. long and scarcely more than one-fourth as long as the width of the body. The legs are more distinct and are considerably longer than the width of the anterior segments where only they can be seen; a single unusually stout pair is attached to each of the first two segments behind the head, much stouter than, though of the same length as, the legs behind them, probably from being preserved on a front instead of a lateral view, thus indicating the possible paddle-like condition of legs, which appear to be very slender; whether there are other legs attached to those segments is uncertain; these legs are 3.5 mm. long, as long as the width of the body at this point.

The head is considerably larger than the segments behind it and droops as in the second specimen described, falling considerably below the level of the body. As there, the front is full and well rounded, and terminates below in a beak-like projection, forming a very pointed and slightly recurved lip. From the lower portion of the front, at the base as it were of the lip, projects the single, basal, joint of an antenna, which is somewhat obovate in shape and 0.5 mm. long.

This species is remarkable for the suddenness with which, and extent to which, the body tapers; the hinder half as a whole is only about half as broad as the front half as a whole, and somewhere about the middle of the body nearly the whole alteration in size occurs, falling often upon three or four segments. In the character of its spines, it is closely related to the preceding species, but the subdorsal rows are not nearly so distant from each other. It is also related to the same species in the form of the segments as a whole, but differs in this respect from the two following species, in each of which the segments have a peculiar form, and where also the outline of the entire body is different.

The opportunity of studying this species is due mainly to the favor of Mr. J. C. Carr, of Morris, Ill., for whom the species is named and to whose cabinet four of the five specimens belong. The remaining one belongs to the collection of Mr. P. A. Armstrong. They occur in the ironstone nodules of Mazon Creek.

Euphoberia flabellata, nov. sp.

Pl. 10, fig. 15.

Through the kindness of Mr. Pike I have been able, after the other species had been studied, to examine another and tolerably well preserved specimen of this group of myriapods, which can be referred to none of them. It lies upon its side, coiled into the commencement of a very open spiral, and although preserving none of the spines and only a few of the legs, and these imperfectly, it is interesting from the good preservation of the hinder segments, and the exhibition of the dorsal and ventral plates abutting against each other along a l...e passing nearly down the middle of the exposed surface.

The entire body is preserved in its continuity and consists apparently of thirty-five segments besides the head. The body tapers forward from the eighth segment or thereabouts, and rather rapidly, so that the anterior extremity, including the head, which does not appear to be larger than the segments next it, is scarcely one-fourth the width of the eighth segment; behind this, however, it apparently tapers scarcely at all, until near the hinder end, when the last six or eight segments, and especially the last four, rapidly narrow; the dorsal plates however do diminish in size from near the middle of the body backward,

leading to the presumption, that, if better displayed, the creature would show the usual appearance of a swollen second fourth of the body. The dorsal plates are very much larger in the front than in the hind part of the animal, and are nearly quadrate or even slightly broader than long (as exposed), while in the middle they are of equal length and breadth, and posteriorly are longer than broad. This refers however only to the plates as they are shown above the line which appears to separate, along the side of the body, the dorsal and ventral plates; but in the hinder third of the body, or the last dozen segments, one sees far below this line the true rounded lateral edges of the segments; between the two very different margins the ventral plates appear, and continue forward nearly to the head, with occasional indications of the division line between consecutive dorsal plates seen through them, or through which the ventral plates are seen; as in many other fossils, both carboniferous and tertiary, the sutural marks of both an originally underlying and an overlying chitinous mass appear upon the same surface, so as frequently to render it quite uncertain which was originally superincumbent. Judging from these appearances the dorsal plates, perhaps only when flattened, were four or five times broader than long, and in front of the last six segments regularly and fully rounded; in these last six segments, the anterior half is rounded as before, or very nearly so, but the outer hinder angle is produced, bearing a triangular process which extends to the middle of the succeeding segment; together they give a straight margin to the sides of the body at this point, and evidently form by their combination a terminal flap, since the triangular process closes the lateral excavation which the rounded front angle would otherwise create (whence the specific name); a rapid forward and backward movement of this part, after the manner of macruran crustacea, would propel the creature backward in the water; and we have seen that the structure of these myriapods allowed so much freedom of movement between the joints, as to render it no great surprise to find a movement so peculiar for myriapods today indicated by the special structure of the segments. It adds too another fact in support of the theory that these were aquatic or partially aquatic animals.

Perhaps a similar flexibility of the body is indicated by a feature seen in the ventral plates, which seems entirely different from anything hitherto found in the Archipolypoda. These plates, as stated, are visible along the inner side of the body throughout a large part of its length, two to each one of the dorsal plates; and along the middle of their course they are broken by a longitudinal suture, (*i. e.* transverse to the segment), which is only not continuous from one plate to the next on account of the lateral sliding, due to the curled position of the animal; where it becomes straight, at the tail, these breaks are also continuous; in one instance, near the middle of the body, the ventral plate is again broken by a second suture next the dorsal plate, but no similar case is noticed elsewhere. Such a fracturing of the ventral plates has nowhere else been seen in these ancient myriapods from Mazon Creek, although in several the parts equivalent to these are amply exposed; but their regularity here is such that it cannot be looked upon as accidental, but only as an inherent structural feature, and reminds one of the repeated and regular fracture of the dorsal plates in Xylobius, where I have shown this peculiarity to be a feature of the entire genus.

Next the outer side of the coiled specimen one sees, partly on one stone, partly on its counterpart, a partial duplicate as it were of the fossil, a feature which I have seen in

other fossils, and for which I scarcely understand how to account; it is as if a cast of the creature had been taken, left connected at one edge, then turned over on this edge as by a hinge, without rupture, and laid down beside it; for here, and always, if I rightly recollect, it is concave while the fossil proper is convex. But here at least it does not perfectly repeat the parts which lie beside it, especially in that portion of it which I have had drawn, and which is on the half of the stone on which the fossil lies in relief; for the structure of the surface is quite different, and is uniformly flat (excepting for the general concave curve of the whole) instead of showing the irregularities of the bosses on which the spines rest, noticeable in the fossil itself; this surface is finely and regularly striate in a transverse sense, a feature which no doubt belongs to the surface of the fossil at this point, since it is found elsewhere, but which does not appear here on the specimen proper. This fine transverse striation of the surface is a marked feature of this species, and seems to be confined to the dorsal plates, although in the portion of which we have just spoken it extends over a great breadth, apparently as great as the entire supposed width of the dorsal plates, instead of being limited to the narrow breadth of the portion truly exposed at their side. The fine striation seen over the lower half of the body apically is either adventitious or it belongs to some similar cast as this puzzling duplicate; it lies beneath the body in a different axis, for the lines are oblique to the true plates of the fossil, whether dorsal or ventral, and extend slightly beyond their actual limit.

No spines are preserved, but their position can be determined to be the same as in other species by the bosses which mark the bases of the upper series, and in a few places by the small pits which mark the casts of the underlying spines of the lower series, seen through the segments above. Neither can the legs be made out, but only faint indications of them here and there of no value.

There is however an additional though problematical feature in this fossil, of much interest. Below the sixth segment behind the head, but still at some distance from it and therefore not necessarily connected with it, is the impression of a long and slender, straight, rod-like body, consisting of a close series of delicate transverse impressed lines, cut by a central longitudinal impressed line; it is half as long again as the width of the exposed dorsal plates at this point, and nearly or quite as slender as the legs must be. Taken by itself, it would appear of little importance, detached as it is from the body; but considered with somewhat similar instances in other species of a long and straight appendage to segments at about this point, it cannot be denied that it may indicate an intromittent male organ at this point.

The length of the body, if uncoiled, would be about 44 mm.; its extreme width 4.5 mm.; its width next the head 1.75 mm.; and its width at the seventh segment from the tail 3.8 mm.; the length of the dorsal plates in the middle of the body is 2.1 mm.; the length of the problematical rod 3.2 mm. The specimen comes from the Mazon Creek nodules, and was sent me for study by Mr. J. W. Pike.

Euphoberia flabellata differs strikingly from the other species described in the form of the terminal segments, as well as in the comparative stoutness of the entire body, and its unusually tapering anterior extremity and small head. The spines being unknown and no clear indications of the legs preserved, these important features necessary to distinguish a creature of this sort are much to be desired, but the further distinction of a transversely

striate surface of the body may be mentioned. It would seem in some of its features to have closer resemblances than other Euphoberiae to the genus Amynilyspes.

Euphoberia anguilla, nov. sp.

Pl. 9, fig. 20.

The single specimen upon which this species is founded is very obscure, but differs so much from all the others in the parts that can be made out that it must be referred to a distinct species. It is probably a complete animal preserved so as to show a dorsal aspect, bent laterally but not abruptly behind the middle, and the whole, besides, curved in a sinuous manner. The body is remarkably long and slender, broadest from the seventh to tenth segments, tapering in front somewhat rapidly, so that the head, which is somewhat narrower than the segment behind it, is scarcely more than half as broad as the broadest part of the body; behind the tenth segment it tapers very gradually indeed and with great uniformity over considerably more than half the body, so that the hinder end is only two-fifths the width of the broadest part; this and its serpentine position give it an eel-like appearance; the length of the body is about 50 mm.; its greatest breadth 3 mm.; its breadth at posterior extremity 1.2 mm. The head, as stated, is narrower than the following segment and of the same length, subquadrate in form with a flatly rounded front; no appendages can be made out. The segments of the body are difficult to enumerate, owing to the obscurity of certain parts, and especially at the bend of the body, but there are somewhere between 32 and 36 and probably the number is 34. The body, although almost completely flattened in preservation, does not wholly conceal evidence of a former transverse ridging of the anterior part of each segment, not shown in the figure; probably also the body was cylindrical. The segments themselves vary considerably in their proportions, those at the posterior end being much longer in proportion to their width than in the other parts of the body. The last six or seven segments for instance show a gradation from an almost perfectly square form, in the last segment, to a quadrate segment twice as broad as long; while directly in front of this, and also in the broadest part of the body, they are three times as broad as long.

Marks of the position of some of the subdorsal spines can be made out with difficulty, showing that these were not distant from each other. There is also on one side of the broadest part of the body a faint indication of a simple, straight, short, conical, outward directed, lateral spine, next the anterior margin of two or three successive segments; it is scarcely more than one-fourth as long as the width of the same segments. No legs are visible.

This species is remarkable for its extreme slenderness and the delicate tapering of the body, and the length of the posterior segments. In all these respects it differs strikingly from all the species described.

The specimen is from Mazon Creek and was submitted for study by Mr. J. C. Carr, of Morris, Ill.

Genus AMYNILYSPES, nov. gen. (*ἀμύνω, ἰλυσπάομα.*)

Spines so far as known simple, conical and pointed, arranged in dorsolateral rows only; segments nearly four times as broad as long, the dorsal plates terminating below in probably free rounded flaps; the extremities and perhaps the whole of the body more or less onisciform.

This genus, represented by a single species and a fragmentary one at that, is so evidently distinct from Euphoberia, to which it is most nearly allied, that there can hardly be any question of the undesirability of placing it therein even provisionally. Its definite separation will call attention to its distinguishing characteristics and bring to light, much sooner than would otherwise be the case, allied forms in carboniferous beds.

Amynilyspes Wortheni, nov. sp.

Pl. 10, figs. 1–4, 9.

A single specimen and its counterpart represent the anterior extremity of the body with about ten or eleven segments. From these it would appear that the form of the body itself did not taper anteriorly, the first three segments behind the head forming with it the common rounded front of the body, each of the three segments becoming successively narrower and shorter from behind forward, while the head, still narrower but a little longer, completed the onisciform hood which all combined to form. The body appears to have been stoutly arched, a little flattened above, the sides and front equally deflected, and by the compression of the ventral rings perhaps reaching or nearly reaching the surface on which the creature crawled. With the exception of such modifications as are required for those in front to form the hood, the segments are all alike, each being nearly four times broader than long, and divided about equally into a longitudinally and strongly arched anterior half, and a gently arched posterior half; both portions help to form the deflected lateral lobes, which are triangular, well rounded, and terminate rather in advance of the middle; at the outer edge of the dorsal field, the anterior lobe bears on each side a spine, straight, erect, simple, scarcely tapering above the basal boss until near the bluntly pointed tip, about half as long as the space between the two spines of the same segment; they are borne by every segment behind the head and are just as long on the narrower first and second segments as elsewhere. The head is a little more than half as broad as the entire body, as seen in the specimen simple, and forms the greater part of the front of the hoof-like anterior extremity of the body; no appendages can be made out.

The length of the fragment is 18 mm.; its width 8.1 mm; length of segments 2.15 mm.; length of lateral deflected lobes 2.5 mm.; length of spines 2.8 mm.; breadth of head 5.4 mm.; length of the deflected head-shield 2.9 mm.; space between spines of same segment 5.6 mm.

The single specimen comes from Mazon Creek and was received for study from Mr. P. A. Armstrong. I have dedicated the species to Professor A. H. Worthen, who was the first, with Mr. Meek, to detect the myriapodan character of these spined articulates in his Illinois Geological Reports and elsewhere.

Genus Eileticus, nov. gen. (*εἰλητικός.*)

Segments longer than in the other genera, being considerably less than twice as broad as long, very few in number, and furnished in place of spines with a series of tubercles, of which there are more than one in the same row upon a single segment.

Although presenting at first glance a very different appearance from the types already described, there seems to be no reason why it should be separated very widely from them; the spines are merely reduced to tubercles, and this reduction allows their multiplication along any one line, especially when the segments are at the same time longer than com-

mon. As in the other types, we find a pair of legs attached to the first segment behind the head and the head composed of only one segment; such agreement in general features will not permit a wide distinction, while the minor differences which do occur are certainly of generic value, especially when several are correlated.

Eileticus anthracinus, nov. sp.

Pl. 10, figs. 5, 6.

This species is founded upon a single individual, exhibiting the lateral and partly dorsal view of the anterior portion of the animal; how much is lost posteriorly cannot be positively stated, but the body is unusually stout and short, is largest from the fourth to the eighth segments, and tapers toward either end, slightly in front, rapidly behind, so as rather to indicate that the creature is nearly all preserved; the body was transversely arched and probably nearly cylindrical. It is 44 mm. long and 7.5 mm. broad in the widest part. The head (Pl. 10, fig. 5) is very obscure, but it can be stated to have been well rounded in front, very shallow and broad; the shortness of the head is the more remarkable from its contrast with the great length of the segments, being not one-third their length; from the upper extremity of the front projects a very obscure appendage, which is nearly as long as the depth of the head, very slender, regularly tapering to a point, nearly straight, slightly curved forward, and projecting upward and a little forward; it has some appearance of being broken into a large number of joints.

The segments behind the head are only eleven in number; longitudinally they are perfectly flat, showing no sort of appearance of an anterior transverse ridge, but they are nevertheless composed of two nearly equal parts, a slightly larger anterior part which appears to have been more chitinous, and a posterior more membranous; these segments in the broadest part of the body are 5.5 mm. long, so that they are only half as broad again as long; their surface is entirely smooth excepting for the low mammiform tubercles which take the place of the spines, and which appear to be arranged in low lateral and subdorsal rows. In the lateral row there are two to each segment in the same row, one in either longitudinal half of the segment, of which that on the anterior half appears so much more prominent that it may be the base only of a real spine; in the subdorsal rows, there are three in a row on each segment and confined to the anterior half of the same; these mammiform elevations are shallow and transversely ova or roundish.

Three or four legs are preserved at the anterior extremity, showing the diplopodous character of the fossil and that the legs were long and slender; they are apparently about 6 mm. long where the body is 7 mm. broad, and they are about 0.5 mm. broad in the middle; they appear to be flattened, but from their fragmentary nature no determination of their jointing can be reached. They are interesting from their attachments, for one of them certainly proceeds from (though it is not in absolute connection with) the anterior part of the second segment behind the head, while one in front of it is similarly related to the posterior portion of the first segment; there is also something that looks like the fragment of a leg in part of the last, and which, if so, must be a second leg to the first segment behind the head.

This specimen comes also from the Mazon Creek nodules and was communicated by Prof. A. H. Worthen, of Springfield, Ill.

It may be well, in closing this paper, to refer to other myriapodal or supposed myriapodal remains from the paleozoic formations. No mention has been made of one, *Palaeojulus dyadicus* Geinitz, from the Saxon Permian, because its myriapodal nature has been denied,[1] and it is now conceded by its author to be a fern, as shown by Sterzel, and in any event is too imperfect to be discussed here. Three species of Iulus have also been named (only) by Frič[2] from the Permian rocks of Bohemia. *Anthracerpes typus* from the Mazon Creek beds described by Meek and Worthen,[3] which these authors were "rather inclined to view as a myriapod" when first described, has been referred to the worms, and was afterward so considered by its describers; it is perhaps very fragmentary and may belong here. Goldenberg describes and figures,[4] under the name of *Athopleurion* [*Arthropleurion?*] *inermis*, a jointed fossil from the coal measures of Saarbrück, which he considers a crustacean, perhaps allied to Arthropleura, and which may possibly be a myriapod; it is, however, not worth discussion until something more perfect and somewhat resembling it is found. Finally Jordan has described and figured,[5] and Goldenberg[6] also, another jointed creature, also from near Saarbrück, which they consider a crustacean, and to which Jordan has given the name of *Chonionotus lithanthraca*. It is here reproduced in Pl. 8, fig. 9. It bears certain resemblances to these spiny myriapods, and perhaps belongs to Acantherpestes. It is however a mere fragment, consisting of only five segments, including perhaps the head. The segments are about four times as broad as long, uniform in size, uniformly and not greatly arched, with no division into an anterior and posterior subsegment. There is a mediodorsal groove, a row of approximate subdorsal tubercles (broken bases of spines?) situated centrally on the segments, and a pleurodorsal series of similar but a little smaller tubercles showing only on one side. These extend over the four segments behind the front one; this latter is smooth and well rounded in front, as long as the other segments and may possibly represent the head. The length of the fragment is 14 mm. and its breadth 8 mm. By the presence of two rows of spine-bases (?) on either side above (any lateral series not showing), it must be nearer Acantherpestes than Euphoberia; provided indeed it belongs in this group at all, which the fragmentary nature of the fossil by no means allows us to assert.

[1] Cf. Sterzel, Zeitschr. deutch. geol. Gesellsch., 30: 417–426; Neues Jahrb. Mineral., 1878, 729-731; see also p. 733.

[2] Faun. Gaskohle Böhm., I, 31 (1879).
Geol. Surv. Ill., II, 409, pl. 32, fig. 1.

[4] Fauna saraep. foss., II, 48, pl. 2, fig. 30.

[5] Palaeontogr., IV, 12-13, tab. 2, fig. 3.

[6] Faun saraep. foss., I, 21, pl. 1, fig. 19.

Explanation of the Plates.

PLATE VII a.

Acantherpestes major. Attempted restoration of a specimen, not of the largest size, for which there was not room on the plate. The body is made rather too slender and not sufficiently tapering; the head, being very imperfectly known, is concealed by a drooping frond of *Neuropteris Clarksoni* Lesq. The specimen is represented as leaving the water in which it is still swimming by means of its hinder legs, and as creeping up the trunk of a Lepidodrendron (*L. vestitum* Lesq.). Upon the trunk crawls a cockroach, *Etoblattina mazona* Scudd., while a broken stem of a Calamites (*C. Cistii* Brongn.) has partly fallen into a clump of fern, *Neuropteris Loeschii* Brongn. All the figures are of the natural size, and represent species found in the nodules of Mazon Creek. The plants however, with the exception of the last, are among the rarer species. Drawn by J. S. Kingsley.

PLATE VIII.

[Figs. 4 and 10 are from the drawings of J. H. Blake; figs. 5 and 9 are copied; the remainder are by J. S. Kingsley. All the original drawings are from specimens in the collection of Mr. Carr.]

Fig. 1. *Acantherpestes major* ½. This specimen shows in the middle the interior faces of the ventral plates, and elsewhere the dorsal plates.

Fig. 2. *The same* ½. The reverse of the central portions of fig. 1, showing nearly the appearance of the under surface of the body.

Fig. 3. *The same* ½. The central portion of fig. 1, magnified.

Fig. 4. *The same* $\frac{1}{10}$. A pair of the supposed branchial supports, as they appear in fig. 2, enlarged.

Fig. 5. *Acantherpestes Brodiei* of England ½. Copied from Pl. 1, fig. 11, of Brodie's Fossil insects of the secondary rocks of England.

Fig. 6. *Acantherpestes major* ½. The most perfect large specimen that has been discovered.

Fig. 7. *The same* ½. One of the disk-like bodies which cover the surface of the whole fossil excepting the legs.

Fig. 8. *The same* ½. One of the subdorsal spines of fig. 6, on the hinder part of the body; it unfortunately does not show the base of the third spinule referred to in the text, the original drawing having been lost.

Fig. 9. *Chonionotus lithanthraca* of Germany ½. Copied from Palaeontographica, Vol. IV, pl. 2, fig. 3.

Fig. 10. *Acantherpestes major* ½. The head of a third specimen, to show the eye.

Fig. 11. *The same* ½. Three adjoining legs from the middle of the body of the large specimen represented in fig. 6.

PLATE IX.

[Figs. 7, 8, 21 and 23 are copied. The others are from drawings by J. S. Kingsley.]

Fig. 1. *Euphoberia armigera* ½. Specimen from Mr. Carr's cabinet.

Fig. 2. *The same* ½. An enlarged spine from the above.

Fig. 3. *The same* ½. An enlarged view of the head of the above.

Fig. 4. *Euphoberia Carri* ½. Part of the anterior segment of the specimen shown in fig. 16.

Fig. 5. *Euphoberia armigera* ½. Anterior extremity of the specimen shown in the next figure.

Fig. 6. *The same.* ½. Specimen from Mr. Worthen's collection.

Fig. 7. *Euphoberia Brownii* of Scotland. Enlarged view of some of the segments. Copied from the Geological Magazine, Vol. VIII, pl. 3, fig, 6 *b*.

Fig. 8. *The same.* One of the legs still further enlarged. Copied from the same, fig. 6 *c*.

Fig. 9. *Euphoberia Carri* ½. The doubled specimen from Mr. Carr's collection.

Fig. 10. *The same* ½. One of the legs, poorly preserved, from the same specimen.

Fig. 11. *The same* ½. The apparently forked spine of the same specimen.

Fig. 12. *The same* ½. The reverse of the same specimen.

Fig. 13. *Euphoberia armigera* ½. Two of the segments of the anterior half of the specimen shown in fig. 6, exhibiting the spines.

Fig. 14. *Euphoberia Carri* ⅔. The head of the specimen shown in fig. 12, enlarged.
Fig. 15. *The same* ⅔. The head of the specimen shown in fig. 9, enlarged.
Fig. 16. *The same* ½. The L-shaped specimen from Mr. Carr's collection.
Fig. 17. *The same* ½. A pair of the spines from the anterior end of the last mentioned specimen.
Fig. 18. *The same* ½. One of the legs on the hinder part of the body of the same.
Fig. 19. *The same* ⅔. One of the spines on the hinder part of the body of the same.
Fig. 20. *Euphoberia anguilla* ⅔. From Mr. Carr's collection.
Fig. 21. *Euphoberia Browni* of Scotland ½. Copied from the Geological Magazine, Vol. VIII, pl. 3, fig. 6 *a*.
Fig. 22. *Euphoberia granosa* ⅔. The specimen shown in fig. 25, enlarged.
Fig. 23. *Euphoberia ferox* of England ½. Copied from Woodward's figure in the Geological Magazine, Vol. X. p. 105.
Fig. 24. *Euphoberia granosa* ½. The tenth segment of the specimen shown in the next figure, with the spine.
Fig. 25. *The same* ½. From Mr. Worthen's collection.
Fig. 26. *The same* ⅔. Reverse of the specimen shown in figs. 22 and 25.

PLATE X.

[Figs. 5, 6, 11, 16, were drawn by J. S. Kingsley; the others by J. H. Blake.]

Fig. 1. *Amynilyspes Wortheni* ⅔. Dorsal view of the fossil in relief. From the collection of Mr. Armstrong.
Fig. 2. *The same* ⅔. Dorso-lateral view of the same.
Fig. 3. *The same* ⅔. Lateral view of the same.
Fig. 4. *The same* ⅔. View of the cast from above.
Fig. 5. *Eileticus anthracinus* ⅔. The anterior portion of fig. 6, enlarged. The fractures in the third appendage are accidental and do not represent joints.
Fig. 6. *The same* ½. The entire specimen. From the collection of Mr. Worthen.
Fig. 7. *Euphoberia armigera*. The anterior portion ¼, showing the head and antennae; and the succeeding segments of the anterior part of the body ⅔, showing the spines; the hinder segment of the more magnified portion is repeated in the front segment of the less magnified part. From the collection of Mr. Bliss.
Fig. 8. *The same* ⅔. Three or four segments from the stouter part of the body, showing not only the spines and legs, but also the stigmata. From the collection of Mr. Pike.
Fig. 9. *Amynilyspes Wortheni* ⅔. The front spine of figs. 1–3.
Fig. 10. *Euphoberia armigera* ½. One of the legs, showing very well the division into joints. From the collection of Mr. Carr.
Fig. 11. *Euphoberia horrida* ½. From Mr. Carr's collection.
Fig. 12. *The same* ⅔. The supposed intromittent organ. From the collection of Mr. Armstrong.
Fig. 13. *Euphoberia granosa* ⅔. The anterior portion of the specimen, showing the head and antennae, the legs, and a few spines. From Mr. Carr's collection.
Fig. 14. *Euphoberia horrrida* $\frac{2}{1}$⁰. A fragment of fig. 11, from near the middle of the specimen on the right side, to show the character of the surface.
Fig. 15. *Euphoberia flabellata* ⅔. From Mr. Pike's collection.
Fig. 16. *Euphoberia Carri* ⅔. From Mr. Carr's collection.
Fig. 17. *The same* ⅔. The anterior portion of the body, showing the basal joint of the antenna. From Mr. Armstrong's collection.
Fig. 18. *The same* ⅔. The anterior portion of the reverse of fig. 16, to show better the head, with its eye and antennae, as well as the legs, the comparative breadth of the anterior ones of which is the opposite of what obtains in fig. 16.

Note. The introductory part of this paper, nearly as given here, appeared in the American Journal of Science for March, 1881.

The Carboniferous Hexapod Insects of Great Britain.

ALTHOUGH it is very nearly fifty years since Audouin first announced the discovery of insect remains in the coal-measures of England, the number of known forms from that country is still so small that they may be counted upon the fingers of one hand. The addition of two species to that number, which I am able through the kindness of Rev. P. B. Brodie to make at the present time, is therefore of more than common significance. Each of these, moreover, has a special interest, the one from its striking color-contrasts, the other from its gigantic size; and both throw so much new light upon the ancient insect fauna of Great Britain that I venture to pass all the neuropterous forms under review, partly to clear away certain misapprehensions concerning the affinities of those that have been described, partly with the view of vindicating the accuracy of Audouin's early announcement; partly also in the hope that this may lead to the discovery of more forms in these older beds, where every addition to our knowledge is likely to be of more than ordinary importance.

Both the additional forms represent genera hitherto unknown, as do also each of those already described. To the first of the new types we may apply the generic name

Brodia nov. gen.

In this genus the wing is long and slender, shaped somewhat as in Panorpa, slightly pedunculated at the base; the costal margin is nearly straight, being very gently and and equably convex, the lower margin moderately full, straight along the middle portion. The marginal vein forming the border is stout, armed throughout with short prickles or spines (pl. 11, figs. 5, 6). The mediastinal vein is the most indistinct in the wing and situated at a low level (compare pl. 11, fig. 3 and fig. 4); it runs midway between and entirely parallel to the marginal and scapular veins until near its extremity, where it turns upward very gently, terminating in the margin at about the middle of the wing. The scapular vein runs parallel to the margin throughout the wing (as preserved; that is, nearly to the tip) and is situated at a high level; its main branch, which is again at a low level, parts from the vein at an exceedingly slight angle at the end of the basal fifth of the wing, and runs parallel to the main vein, and at a distance from it about equal to the distance of the latter from the margin; this main branch emits half a dozen or more equidistant, oblique veins from its lower side (five are found in the fragment), which run parallel to each other

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toward the outer part of the lower margin; the first of these nervules is at a high level, is thrown off near the base in continuation of the base of the main branch and is more curved than the others, its basal direction being less oblique than theirs. The externomedian vein is a simple, gently arcuate vein, running from the base to a little beyond the middle of the lower margin, and emitting from its upper side at the middle of its course a single branch, arcuate at base, which, like the main vein, has a course parallel to the scapular branches; both main vein and branch are situated at a very low level. The internomedian vein is nearly straight, a little arcuate, especially in the apical half, and perfectly simple, situated at a high level and terminating a little before the middle of the lower margin. The anal vein, neither elevated nor depressed, is forked at the base, one fork running parallel to the internomedian vein in the basal half, and beyond curving downward to the margin, which is slightly indented at this point; and the other again forking, the forks similar, curving, but very short.

There are several distinct cross-veins in the wing; one important one, a long and curving vein, connects the externomedian and scapular vein, near the base, and appears to form a downward curving basal continuation of the main branch of the scapular, making it look like a superior branch of the lower vein; the others are transverse and most of them at exactly right angles to the nervures, and they are all situated in the dark bands. Besides these, there are a large number of fainter cross-veins transverse to the nervures they connect, pretty regularly and uniformily distributed over the wing below the main scapular vein, forming quadrangular cells which over most of the wing are more than twice as broad as long.

The genus is dedicated to my honored friend Rev. Peter Bellinger Brodie; as his name will always be connected with the fossil insects of England, it is fitting that so notable a form as this should recall his eminent services.

This generic type is an ancient form of Planipennia or true Neuroptera, the structure of whose wings does not agree with that of any of the existing families of the group, but rather shows a combination of features which now distinguish separate families. It has the general aspect of a gigantic Panorpa, borrowed from its form, its markings, the presence of a few scattered cross-veins, and the course of the mediastinal nervure. When, however, its neuration is carefully observed, the scapular vein is seen to be fundamentally different, although its position and the origin of its main branch is similar; for, while in both cases the area it occupies is important, in the Panorpina the main branch divides dichotomously throughout, and its offshoots take a longitudinal direction; while in Brodia, the main branch emits oblique shoots at regular intervals downward and outward, as it does in other Planipennia, but not in Panorpina. The veins below the scapular are also very different from what they are in Panorpina, and relatively to the rest of the wing much less important.

With the Hemerobina, the wide space between whose marginal and mediastinal veins is filled with numerous oblique and generally forked veinlets, and whose scapular vein has numerous sectors, this ancient type has less to do. In this group the mediastinal vein extends nearly to the tip of the wing, while in Brodia it terminates a little beyond the middle. The Hemerobina, however, differ from other Planipennia in the insignificant part usually

played by the externomedian vein, which is frequently almost entirely simple or only forked once in the apical half of its course. This peculiarity is borrowed, though not in a striking degree, by Brodia, where this vein is forked once near the middle; but whose branches, widely distant like those of the scapular vein, cover a considerable area.

The more essential features of this ancient wing, however, foreshadow the characteristics of the Sialina. In form, while it is not very different, it has none of the arching of the costa almost universal among Sialina, and usually accompanied in modern types by a broad space between the marginal and mediastinal veins, not at all displayed by Brodia. In the brevity of the mediastinal vein Brodia resembles the Raphidiidæ, but the neuration of the rest of the wing is completely different; while in the Sialina proper the mediastinal vein always continues nearly to the tip of the wing. The course and distribution of the branches of the scapular vein, however, are of greater importance, and in this respect Brodia agrees very well with the Sialina; again, however, the simplicity of the internomedian vein in Brodia, where it consists of only a single undivided ray, is very different from that now found in Sialina, where it is always divided and often plays a somewhat important part.

Brodia, then, is a planipennian in a broad sense, refusing to affiliate closely with the restricted families of the present day. Nor does it appear to be intimately related to any paleozoic insect yet described. It is also peculiar for possessing a very large number of fine cross-veins or wrinkles, besides the stout cross-veins which are scattered here and there over the wing; the latter are, however, confined to dark patches to be mentioned presently; while the former are uniformly distributed over the wing, subequidistant, and always run at right angles to the nervures they connect, even where, by keeping that course, they strike the often obliquely directed, stouter cross-veins.

In the preservation of its colors (pl. 11, fig. 7), Brodia is the most striking instance known among paleozoic insects the markings are sharply defined and, to judge from illustrations, more deeply tinted than in *Protophasma Dumasii* recently described by Brongniart, who has drawn particular attention to this remarkable feature in the wings; or than in the longer known *Gryllacris lithanthraca* of Goldenberg. In allusion to this colorational feature, the species may bear the name of

Brodia priscotincta nov. sp.

Pl. 11, figs. 3-7.

The wing is a rather large one, being probably about 55 mm. long (the fragment is 44 mm. long) and 12 mm. broad in the middle. Both front and hind margins are very dark colored and are distinctly furnished at the extreme edge with a row of fine bristly teeth, short, stout, triangular, pointed, black, directed outward and forward (or backward), and on the costal edge more closely approximated away from (pl. 11, fig. 5) than near (pl. 11, fig. 6) the base; beyond the base, also, the marginal vein is furnished along its lower edge with a similar armature, only the teeth, here also black, are depressed, directed outward, and not nearly so sharply pointed (pl. 11, fig. 5).

The stone on which the wing is preserved is of a dull, impure gray color (pl. 11, fig. 7), and the hyaline parts of the wing do not differ from it in tint. Nearly half of the wing

however is of a much darker shade, the markings consisting mainly of three broad transverse belts, which cross the wing from the scapular vein to the lower margin, one near the middle of the wing and one near the middle of either half; these, and especially the outer two, are of a distinct though dull umber brown; the same deep tint is also found throughout the space between the scapular vein and its main parallel branch, but the whole costal margin above the scapular vein is hyaline; the apex of the wing, which is lost, was probably tipped with the dark color. Of the three transverse belts the outermost is pretty regularly transverse, its inner margin following an irregular zigzag course, generally at right angles to the costal margin, from the base of the third offshoot of the main scapular branch to the tip of the lower externomedian branch; its outer margin follows a similar direction downward from the base of the fourth offshoot of the main scapular branch, until it reaches the second offshoot, when it follows that outward (to the broken part of the wing). The middle transverse belt is less regular, being nearly broken in the middle, its lower half hardly more than half as broad as its upper half and thrust a little further outward; the upper half is seated on the extreme base of the upper externomedian branch and, broadening upward, reaches from near the base of the first offshoot of the main scapular branch to nearly midway between the second and third offshoot; the lower half is equal and tolerably regular, its middle line opposite the lower termination of the outer margin of the upper half, its outer margin terminating below at the tip of the internomedian vein. The inner belt is broken into three fragments; the upper, between the scapular and externomedian veins, reaches from where these veins begin to diverge to the extremity of the curved cross-vein uniting the two veins; the second, between the externomedian and internomedian veins, extends in neither direction so far as the one above, and is terminated outwardly by a distinct and oblique cross-vein; the third occupies the outer half of the anal area. Besides there are a few dark cloudy spots at the base, one following the lower edge of the internomedian vein, and others parts of the anal veins.

The heavier cross-veins, besides the one referred to in the generic description, at the base of the main scapular branch, are the following: In the scapular area, four equidistant transverse veins between the main stem and the main branch; two approximate transverse veins between the third and fourth offshoots of the main branch,— both in the outer dark belt and the outer forming its outer margin; one in the same belt in the interspace below, and in continuation of the inner of the transverse veins above it; one in the middle belt, oblique to the nervures but at right angles to the costal margin, between the scapular and externomedian veins; two others in the same interspace in the outer belt, a little oblique to the nervures, in the opposite sense to the preceding; two others in continuation of these, but transverse to the nervures between the externomedian branches; another in the same interspace in the middle belt, also transverse; one in continuation of this, in the interspace below, forming the inner margin of the middle belt, besides another outside of it in the externo-internomedian interspace, both transverse, and one in the same interspace, very oblique, forming the outer margin of the inner belt; two in the interspace below, one oblique, its lower extremity at the tip of the anal vein, the other transverse, above the middle of the lower spot of the inner belt; and finally one, very oblique, in continuation of the preceding. It thus appears that all the heavy cross nervules fall in the three transverse dark belts and that with few exceptions those which are oblique to the neighboring longitudinal

nervures are situated in the interspace between main veins, while those which are transverse are between branches of a single vein.

The specimen comes from the coal measures near Tipton, Staffordshire, where it was obtained by Mr. C. Beale and was kindly sent to me for study by the Rev. P. B. Brodie, Vicar of Rowington, near Warwick, to whom it now belongs. The face examined is the upper surface of the right wing, or else the reverse of the lower surface of the left wing.

The second species may be called:

Archaeoptilus ingens nov. sp. et gen.

Pl. 11, figs. 10-12.

The costal margin, or marginal vein, is pretty strongly convex at the base, but beyond is straight; no other margin is preserved, and only the base of this, but the wide separation and straight course of the upper, and the sweeping curve of the lower, veins indicate an immense expanse of wing both in length and breadth; all the veins are exceedingly stout. The mediastinal vein is at first directed in a straight line toward (presumably) the middle of the costal margin, but at a distance of 20 mm. from the base bends very gently and very slightly downward, still continuing a nearly straight course, indicating the extension of the vein to the tip or nearly to the tip of the wing; at the extremity of the fragment, at about 40 mm. from the base, it lies midway between the marginal and scapular veins; but previous to this it lies nearer the latter. It lies in a slight depression, a little lower than the level of the interspaces beside it, as well as that of the marginal vein. The scapular vein, on the contrary, though broad and flattened like all the rest, lies at a high level from which the wing slopes in a rounded curve equally on both sides; it starts from the middle of the base of the wing, and following a course subparallel to the costal margin, especially beyond the extreme base of the latter, moves in a broad inconspicuous curve, apparently reaching the highest point of the curve at the extremity of the fragment. The externomedian vein crowds against the scapular at base and, at a distance of only about 15 mm. therefrom, it divides into two branches, the upper of which continues the course of the undivided base, but diverges very slightly from the scapular vein; so that at the end of the fragment the two veins are separated by scarcely more than the width of one of them. Like the scapular vein it lies at a high level, but the lower branch, on the contrary, falls rapidly beyond its origin, so as to lie, at the terminal portion of the fragment, at a lower level than the mediastinal vein; but unlike the mediastinal, and indeed all the other principal veins, it is weak, having less than one-fifth the width of the scapular vein; it diverges with tolerable rapidity from the main branch, and divides equally the space between it and the internomedian vein. The latter vein, again heavy, and also closely crowded at base against the veins above, as far as the division of the externomedian vein, sweeps downward in a pretty strong curve beyond this point, so that at the end of the fragment, up to which it is undivided, it is as far from the upper branch of the externomedian, as the scapular is from the mediastinal. It lies again at a higher level, the space between the lower branch of the externomedian and the internal forming a broad gentle arch, lower and less conspicuous than that between the mediastinal and lower externomedian veins, but otherwise similar to it, at the summit of

which lies this vein. The anal vein is not crowded against those above it; it has a curve even more sweeping than, but running subparallel to, the internomedian vein, and emits several similarly curving branches, of which fragments of two can be seen upon the stone; at base it is separated from the veins above by a space several times its own width, and at the extreme base it seems to part more widely from them, and to have its root attachments at a considerable remove from them; the vein itself is neither depressed nor elevated.

The cross-veins of the wing are very conspicuous, especially in the two broad upper interspaces; here they are prominent, in relief, generally simple, occasionally forking, and then rather widely, generally curved or sinuous, subequidistant, and dividing the interspaces into cells generally about twice as broad as long. In the mediastino-scapular interspace they are generally regularly curved with the convexity outward; and the same is usually the case with the other cross-veins of the interspaces below, in all of which they are found (even in the slender interspace between the scapular and the upper branch of the externomedian vein); though here they are much feebler, more numerous, uniform and simple; they are especially feeble and numerous in the internomedio-anal interspace, as well as in the slight fragments that remain of the anal area.

Besides these cross-veins are a few others, the nature of which it is more difficult to divine; such are three short, curving, transverse impressions which cross continuously the base of scapular and externomedian veins; and also a considerable number of transverse impressions on these same veins away from the base generally crossing the vein, sometimes only half crossing it and usually in continuation of the ordinary cross-veins in the interspace below; these latter cross-veins are not shown in the figures; they are not conspicuous in the fossil and appear to be confined to these two veins.

In addition to these points it may be mentioned that the only fragment of a border which remains shows that the edge of the wing was spinous; toward the base the costal margin is furnished on its convex portion (pl. 11, fig. 11) with frequent short, oblique, spinous points, which further out seem to be altered to distant, recumbent, outward directed, longer and rather slender spines.

Length of the fragment 43 mm.; breadth 32 mm.; greatest width of upper interspace 10 mm.

This fragment is remarkable for representing the largest known insect-wing from the paleozoic rocks, not excepting the *Acridites formosus* of Goldenberg from Saarbrück, or my *Megathentomum pustulatum* from Illinois. Certainly not more, probably much less, than the fifth of the wing is preserved (pl. 11, fig. 12), but the direction of the veins, their very great robustness, and the extraordinary distance apart of the upper three, are clear indications that the spread of wing enjoyed by this insect was not less than 25 cm., and may have been even more than 35 cm., while the width could not have been far from 6 cm. All the principal veins are a millimeter or more thick.

The specimen occupies the entire surface of a reddish-brown iron-stone nodule and came from the coal measures near Chesterfield, between Shelton and Clayborne, Derbyshire, England; it was received for examination from Rev. P. B. Brodie, to whose collection it belongs. The reverse is in the British Museum, from which I have received excellent casts through

Dr. Henry Woodward. The specimen before me represents the upper surface of a left wing, or else the reverse of the lower surface of a right wing.

The exact position of a fragment as small (proportionally speaking) as this would seem to be indeterminable at first sight; and so indeed it would be, were there not other forms living at that time, belonging to a group from which this cannot be separated by anything in the structure of the base of the wing; and yet, as it differs strikingly from all of them in certain features, and from its immense size can be confounded with none, it merits distinct mention and a name. All of the principal veins are present, and from their trend and relative level, and from the width and nature of the interspaces, there can be no question that the insect belongs to the same group as the only other heretofore known neuropterous wings found in Great Britain, viz., *Corydalis Brongniarti* Mantell and *Lithomantis carbonarius* Woodward, and is only to be separated generically from them. Its proper position can therefore best be determined after the structure of those wings has been discussed,—a point to which we will now direct our attention.

Dr. Woodward is assuredly mistaken in referring Lithomantis to "the neighborhood of the Mantidæ," notwithstanding that he supports himself by the adherence to his views of such able entomologists as Messrs. Westwood, Waterhouse and M'Lachlan, who can hardly have made a serious study of the neuration. It bears indeed a vague resemblance to that of the Mantidæ, excepting in the hind wings, where the fullness of the anal area, with its special development of folding rays in the insect of to-day, need not be looked for in its less specialized ancestor; but when the elements of the neuration are examined, the resemblance is seen to be purely superficial. Then it appears that Lithomantis agrees with other ancient types, and not at all with the Mantidæ. The front wing of the Mantidæ has a very peculiar and characteristic neuration. The marginal vein forms the front border of the wing, as I believe it never does in any saltatorial Orthoptera, and always does in the Neuroptera. The mediastinal vein is simple, and runs in close proximity to the scapular, terminating near the tip of the wing. So far there is nothing essentially different from the condition of things in Lithomantis; but in the next three veins all is different. To use the specific example (*Blepharis domina* of Africa) given by Mr. Woodward: the scapular vein is perfectly simple as far as the extreme tip, when it divides into three very short nervules supporting the apical margin. In Lithomantis, however, it emits a stout inferior branch near the middle of the wing, which runs parallel or nearly parallel to the main vein, and probably (if it is like its allies of the time) sends off several branches to the lower apical margin. As this is one of the principal veins of the wing, differences which occur here are significant, and there is hardly any group of insects which has so unimportant a scapular vein as the Mantidæ. The differences are even more striking in the next two veins, better preserved in the fossil. In Blepharis (and it is much the same in all Mantidæ) the externomedian vein is divided at base into two main stems, the upper of which runs in close proximity to the scapular, and in the outer half of the wing sends downward three or four conspicuous oblique veins, which appear at first glance precisely as if they were offshoots of the scapular, which they are not at all; they only perform the office of such offshoots in other wings; the lower branch takes an irregularly longitudinal course below the upper branch, and emits similar veinlets to the lower margin; and the entire area occupied by the two branches of this vein and their offshoots covers

very much the larger part of the wing. The internomedian vein, on the contrary, is exceedingly simple, being forked only once (often, in other Mantidæ, not at all), and occupies much less space than even the anal area. Now in Lithomantis the case is very different; the externomedian vein does not divide at all until near the middle, and then only once or twice, its branches covering an area which is certainly much less than a quarter part of the wing; while the internomedian vein subdivides numerously, no less than eight final nervures reaching the margin, and covering an area, certainly as great as, and apparently considerably greater than, that of the externomedian vein. These singular differences between the Mantidæ and Lithomantis, affecting the distribution of the three most important veins of the wing, leave no doubt whatever that the resemblances between the two are only superficial, and that Lithomantis can with no propriety be referred to the Mantidæ.

What place, then, should be assigned to Lithomantis? I believe we should compare it with certain other paleozoic wings, and notably with "*Corydalis Brongniarti*" of Mantell, to which indeed Woodward has himself compared it; speaking of their "marked similarity" and giving at the same time an original figure of this interesting fossil (reproduced in pl. 11, fig. 8).

The last insect, as I shall show, should be referred, neither to the modern genus Corydalis nor to Gryllacris, but is generically distinct from all modern types, and may bear the name of

Lithosialis Brongniarti.

Pl. 11, figs. 1, 2, 8, 9.

This insect is especially interesting from its being the first discovered in paleozoic rocks, and that at a time when, to use the words of Audouin, no fossil insect was known either from the lower oolite, the lias, the keuper, the muschelkalk, or the new red sandstone; still less in any older rocks. How astonishing then it must have been to find this trace in the coal! It was at first supposed to be a plant, and as such was sent by Mantell to Brongniart, with other remains from Shropshire. Brongniart placed it in Audouin's hands, and he drew attention to it on several occasions, — before the Entomological Society of France, the Academy of Sciences, and the Assembly of German Naturalists at Bonn, asserting its relationship to Neuroptera, where he placed it in the neighborhood of Hemerobius, Semblis, Mantispa, and especially of Corydalis. Mantell accordingly figured it in 1839, in his Medals of Creation under the name of Corydalis, adding in the second edition in 1844 the specific name Brongniarti. The figure given by Mantell (reproduced in pl. 11, fig. 9) is thoroughly bad, not one of the veins being correctly drawn, and giving an altogether false idea of the wing; that by Murchison, in the various editions of his "Siluria" (reproduced in pl. 11, fig. 2) is apparently made from the same drawing, and therefore almost equally bad; the anal veins alone are more correct.

No further notice appears to have been taken of this wing until, in 1874, Swinton, and again, in 1876, Woodward, gave us new illustrations of it, (cf. pl. 11, figs. 1 and 8) which leave little to be desired. Swinton thought he had discovered the relics of a stridulating organ at the base of the wing, and compared it to similar characteristics alleged to be

present on the under surface of the front wing of the modern Gryllacris. He accordingly referred the wing to the Orthoptera, and even to the Locustarian genus Gryllacris. This view cannot possibly be maintained, and a more unfortunate comparison could hardly have been made. Swinton himself acknowledges that he could not succeed in finding a species of Gryllacris "with an effective file," and the semblance of one he figures cannot be ascribed to a stridulating apparatus; for (1) the "file" he figures could not produce any sound when brought into contact with a similar structure on the opposite wing, since from their course the two would not be brought into the proper relations to each other, or at least into such relations as they always are brought in stridulating Orthoptera; (2) but it could not be brought at all into contact with the similar part of the opposite wing, the wing-insertions being far apart in Gryllacris, and the supposed file lying at the extreme base of a vein in the middle of the wing; (3) if this were a stridulating organ, it would not only lie in a different area from that in which it lies in all other Locustarians, but would agree with its place in no other Orthoptera whatever.[1]

The supposed file in Gryllacris being no stridulating apparatus, any comparisons between it and the fossil from this point of view are of course misplaced; but, aside from this, the position and course of the supposed file of the fossil is entirely different from that of the supposed file in Gryllacris, more indeed as it really is in Locustarians. But a careful examination of casts of both obverse and reverse, kindly given me by Mr. Woodward, and which show even more details than are given either by Swinton or Woodward (as, for instance, the spiny nature of the edge of the costal margin), brings nothing to light which lends any support to this supposition.

In his comparison of the general neuration of the fossil wing and the modern Gryllacris, Mr. Swinton's language is vague; and his conclusion, though evident, is wholly erroneous. It needs only the figures upon his plate to point out the essential differences in the neuration. In the first place, a distinction of prime importance appears in the marginal vein, which forms the border (and is heavily spined) in the fossil, is widely removed from it in Gryllacris, the margin being formed of a film supported by superior offshoots from the marginal vein, which of course do not exist in th fossil. In Gryllacris, the scapular vein is crowded into a narrow space, embracing on the margin only the extreme tip of the wing; while no such contraction appears in the fossil, where the area embraced by this vein must cover the entire apical margin. The externomedian vein of the fossil is closely crowded against the scapular at base, and parts from it beyond with a sweeping curve (as in most Neuroptera), appearing as if a branch of it; while in Gryllacris it lies midway between the adjacent veins, and has scarcely the slightest downward tendency, its branches being equally parallel instead of divergent. The internomedian vein in the fossil is widely separated on either hand from the adjoining veins; while in Gryllacris it is equally crowded with the others. Finally, all the branches of the latter, as well as those of the preceding vein, impinge upon the apical margin in Gryllacris; while in the fossil they strike the lower border of the wing.

[1] Mr. R. Etheridge of the British Museum has examined the original specimen and "is convinced that not the slightest trace of any organ, as figured by Mr. Swinton . . . exists on the specimen in question. The supposed 'stridulating organ' is in fact only a fracture of the surface of the nodule, in which the wing is preserved. This is shown both on the fossil and its counterpart." Geol. Mag. (2) VIII, 298. note.

These differences, many of which separate also most of the families of Orthoptera from those of Neuroptera, prove that the fossil is widely distinct from Gryllacris, which, on its side, has a neuration more nearly allied to that of Neuroptera than, perhaps, any other group of Orthoptera; any comparison with other Orthoptera would therefore be still more vain, the neuration of the fossil wing bearing so much closer resemblance to that of those groups to which Audouin at first referred it.

Compared even with Brodia, it will be seen that the essential features of the neuration are the same, with the single exception of the mediastinal vein, which in Brodia ends on the margin not far from the middle of the wing; while in this ancient "Corydalis" it extends no doubt nearly or quite to the tip. But exactly such a difference as this is found to-day between Raphidiidæ and Sialidæ, and there can be little doubt that all four of the wings which have now been discussed (comprising all the important fragments of wings from the English carboniferous rocks but one — a cockroach) belong to an ancient type of planipennian Neuroptera.

Of these, the two which are most nearly related to each other are, unquestionably, the *Corydalis Brongniarti* of Mantell and the *Lithomantis carbonarius* of Woodward. Indeed, the resemblance between them is so close that one would almost consider them as belonging to the same genus. The basal narrowness of the margino-mediastinal interspace, however, as well as the considerably greater importance of the internomedian area in Lithomantis, forbid this, though the course and general disposition of every principal vein is nearly identical.

Corydalis Brongniarti, then, being generically distinct from its synchronous allies, and widely different from living types, merits a distinctive name, and may be termed Lithosialis, to recall its relationship to the forms to which Audouin first compared it. From Lithomantis it differs in the points just mentioned; from Brodia in the basal breadth of the margino-mediastinal interspace, the much more numerous branching of the lower veins, and the greater extent of the mediastinal, besides the more uniform breadth of the whole wing; from Archæoptilus, in the proportionally narrow area occupied at the base of the wing by the upper two interspaces, and the far later division of the externomedian vein.

Objection would perhaps be made by some to the retention of Woodward's name of Lithomantis for an insect whose supposed resemblance to the Mantidæ is found to be erroneous, and which does not even fall within the suborder to which the Mantidæ belong; but, aside from the fact that it belonged to an age when the characteristic features of Orthoptera and Neuroptera were more or less blended, its outward aspect is at first glance by no means very different from the insect to which Woodward has compared it; and the retention of the name has an historic interest which should not be disregarded; the number of paleozoic insects is not, and is not likely to become, so great as to render the name itself an obstacle to a knowledge and easy recollection of its true affinities.

Attention may here be drawn to the apparent fact (there are many described fossils which I have not yet studied with sufficient attention to speak in any stronger terms) that while all the carboniferous Neuroptera of Great Britain belong to a single group, not only is this group not represented (at least at all conspicuously) in any other locality, whether in Europe or America; but also the prevailing forms of other coal measures, the Dictyoneurae

Termites, etc., are entirely absent from England. It is a noticeable exception to the prevailing uniformity of insect type among carboniferous localities generally. The same exception does not exist among the arachnids and myriapods of Great Britain, as Mr. Woodward has shown in nearly all his papers upon fossil insects.

Concerning the other hexapod insects described from Great Britain we have here nothing to add besides a mere list of all the species hitherto recorded, with which this paper is concluded.

LIST OF THE CARBONIFEROUS HEXAPOD INSECTS OF GREAT BRITAIN.

Neuroptera.

1. **Lithosialis Brongniarti** Scudder, Geol. Mag., (2), viii, 297-300 (1881); — Ib., Harv. Univ. Bull., ii, 175 (1881).
   Corydalis (allied to) Audouin, Ann. Soc. Entom. France, ii, Bull., 7-8 (1833); — Mant., Wond. Geol., ii, 680 (1839); — Murch., Silur. Syst., i, 104-105, fig. *a* on p. 105 (1839); — Ib., Siluria, p. 284, fig. 1 (1854).
   Sialidae (belongs to) Pictet, Traité Paléont., 2e ed., ii, 377-378, pl. 40, fig. 1 (1854).
   Corydalis Brongniarti Mantell, Med. Creat., ii, 575, 578, lign. 124, fig. 2 (1844); — Ib., ib., 2d ed., ii, 551, 554, lign. 181:2 (1854); — Murch., Siluria, 3d ed., 320, foss. 81:1 on p. 321 (1859); — Swint., Geol. Mag., (2), i, 3-5 (1874).
   Gryllacris (Corydalis) Brongniarti Swinton, Geol. Mag., (2) i, 5, pl. 14, fig. 3 (1874); — Woodw., Quart. Journ. Geol. Soc. Lond., xxxii, 60, pl. 9, fig. 2 (1876).
   Gryllacris Brongniarti Novak, Jahrb. geol. Reichsanst., xxx, 73-74, pl. 2, fig. 4 (1880).
   [Coalbrook Dale, Shropshire].
2. **Lithomantis carbonarius** Woodw. Quart. Journ. Geol. Soc. Lond., xxxii, 60-64, pl. 9, fig. 1 (1876); — Scudd., Geol. Mag., (2), viii, 296-300 (1881); — Ib., Harv. Univ. Bull., ii, 175 (1881).
   Archimantis (err. typ.) carbonarius Scudd., Mem. Bost. Soc. Nat. Hist., iii, 18, note 2 (1879); — Ib., Arch. Sc. Phys. Nat., (3) iii, 363 (1880). [Scotland].
3. **Archaeoptilus ingens** Scudd., Geol. Mag., (2) viii, 295, 300 (1881).
   [Near Chesterfield, between Shelton and Clay Lane, Derbyshire].
4. **Brodia priscotincta** Scudd., Geol. Mag., (2), viii, 293-295, 300, fig. on p. 293 (1881).
   [Tipton, Staffordshire].

Orthoptera.

5. **Etoblattina mantidioides** Scudd., Mem. Bost. Soc. Nat. Hist., iii, 72-73, fig. on p. 73, pl. 3, fig. 8 (1879); Ib., Geol. Mag. (2) viii, 300 (1881).
   Blatta sp. Kirkb., Geol. Mag., iv, 389, pl. 17, fig. 6 (1867).
   Blattidium mantidioides Goldenb., Faun. Saraep. Foss., ii, 20 (1877).
   An indeterminate fragment of another wing, perhaps of the same species, is mentioned and figured, fig. 7, by Kirkby as above. [Claxheugh, Durham.]
6. **Phasmidae** sp., Kirkb., Geol. Mag., iv, 389, pl. 17, fig. 8 (1867); — Scudd., Geol. Mag., (2) viii, 300 (1881). [Claxheugh, Durham.]

Coleoptera.

7. **Curculioides Ansticii** Buckl., Geol., ii, 76, pl. 46″, fig. 1 (1837); — Agass., Buckl., Geol., Expl. pl. 46″, pp. 1-2, pl. 46″, fig. 1 (1838); — Mant., Med. Creat., 2d ed., ii, 555 (1854); — Scudd., Geol. Mag., (2), viii, 300 (1881).
   Henila Ansticii Gieb., Ins. Vorw., 143 (1856). [Coalbrook Dale, Shropshire].

The other species described by Buckland as a beetle has been shown to be an arachnid.

EXPLANATION OF PLATE XI.

Fig. 1. *Lithosialis Brongniarti* ½. The figure given by Swinton; copied from Geol. Mag., (2) I, pl. 14, fig. 8. The arrow points at the supposed file.

Fig. 2. *The same.* ½. The figure given by Murchison; copied from his Siluria, 3d ed., p. 321. The figure given by Pictet is copied from the same.

Fig. 3. *Brodia priscotincta.* ½. Showing simply the neuration with the heavier cross veins. Drawn by J. S. Kingsley.

Fig. 4. *The same.* ½. Cross section of the same at the point where the dotted line is placed in fig. 3, to show the different planes at which the veins lie. Drawn by J. S. Kingsley.

Fig. 5. *The same.* 4/1. A bit of the costal margin from near the tip of the wing, showing the double row of approximated depressed teeth. Drawn by J. S. Kingsley. The positions of figs 5 and 6 upon the plate would better have been reversed.

Fig. 6. *The same.* 4/1. A bit of the same margin near the base, showing the single row of more distant and elevated teeth. Drawn by J. S. Kingsley.

Fig. 7. *The same.* ½. The whole wing and stone. Drawn in color by J. H. Blake.

Fig. 8. *Lithosialis Brongniarti.* ½. The figure given by Woodward; copied from the Quart. Journ. Geol. Soc. Lond., XXXII, pl. 9, fig. 2.

Fig. 9. *The same.* ½. The figure given by Mantell; copied from his Medals of Creation, 1st. ed. II, p. 578.

Fig. 10. *Archaeoptilus ingens.* ½. Cross section at the point where the dotted line is placed in fig. 11, to show the different planes at which the veins lie. Drawn by J. S. Kingsley.

Fig. 11. *The same.* ½. Drawn by J. S. Kingsley.

Fig. 12. *The same.* ½. Restored to its presumed size, etc. Drawn by S. H. Scudder.

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Two New and Diverse Types of Carboniferous Myriapods.

CHARACTERISTICS of a distinct type of carboniferous myriapods were recently given in a paper on the Archipolypoda, or gigantic spined myriapods of the coal measures. In collecting the material for that memoir some other striking forms fell under notice, which at first were set aside as having no close connection with my studies; but which, with more ample material and careful inspection, proved to be allied, though remarkably distinct. It is the purpose of the present paper to bring these strange forms to the notice of naturalists. They belong to two distinct types, each differing considerably from other known ancient myriapods. One of these types is here noticed for the first time; the other and more remarkable type is that figured in the Illinois Geological Reports, to which Messrs. Meek and Worthen applied the name of Palaeocampa, and of whose affinities there has been much doubt and some public discussion.[1]

For the opportunity of studying these interesting animals, the writer is entirely indebted to his friends at Morris, Ill., Messrs. J. C. Carr, P. A. Armstrong, and F. T. Bliss, who have generously placed at his disposal the material they have, with great pains and assiduity during a number of years, gathered in the nodules in the shales of Mazon Creek, in that vicinity.

The first of these new forms, to which the name of Trichiulus may be given, probably belongs to the Archipolypoda. Five specimens of different species have been examined, but they do not together furnish all the details that could be desired, even in those points where most of the Euphoberiae and allied genera are sufficiently clear. They may be described (pl. 13) as jointed vermiform myriapods, tapering considerably from in front backward. The segments of the body are unusually short and probably consisted of two ventral plates to every dorsal plate, furnished profusely with rows of papillae, apparently arranged in definite series both longitudinally and transversely, and bearing long flexible hairs which were sometimes much longer than the width of the body and formed a thick and uniform flowing mass entirely concealing the body. The body, and especially the hinder half, was capable of being tightly coiled, as in modern Iulidae; more than this can hardly be said. The relation of dorsal and ventral plates is by no means certain and is presumed mainly from certain features which also occur in some obscure but indubitable specimens of Archipolypoda, and which are there referred with little doubt to a separation of the dorsal and

[1] For reference to this, see the bibliographical citations under the description, *infra*, of Palaeocampa anthrax.

ventral fields. It is also supported by a vague appearance of what seem to be legs on one or two of the specimens, and which show two pairs to each dorsal segment. The close general resemblance of most of the species to the species of Euphoberia is also an argument in favor of the same supposition; and would, perhaps, by itself, be considered sufficient to one studying these forms, were it not for the unexpected discovery of a very distinct type of chilopodiform myriapods next to be considered.

This second type, as we have remarked, has been known to naturalists for some time under the name of Palaeocampa, given to it by Messrs. Meek and Worthen in 1865, under the supposition that it was a caterpillar. The original specimen, figured in 1866, was destroyed by fire a year or two later, but a better specimen enabled these naturalists to give further description of the spines in the same year that I questioned the lepidopterous nature of the fossil; and to express the opinion, that, as I had suggested from the figure alone, "it was more probably a worm." I have now received, through the favor of Messrs. Carr and Bliss, three remarkably well preserved specimens of what is undoubtedly the same creature, and which show that the animal combined some most extraordinary features. One of these specimens, the discovery of Mr. Bliss, shows the legs distinctly on both halves of the split nodule in which it occurs, and gives one much fuller information concerning this ancient creature than one could gain from the legless specimens otherwise known.

But for my previous study of the Archipolypoda of Mazon Creek, and the revelation which these ancient types give of the divergence of structure between extinct and modern forms of Myriapoda, it would have been difficult to reach the full conviction that Palaeocampa was a myriapod. It is a caterpillar-like, segmented creature, three or four centimeters long (pl. 12), composed of ten similar and equal segments besides a small head; each of the segments excepting the head bears a single pair of stout, clumsy, subfusiform, bluntly pointed legs, as long as the width of the body, and apparently composed of several equal joints. Each segment also bears four cylindrical but spreading bunches of very densely packed, stiff, slender, bluntly tipped, rod-like spines a little longer than the legs. The bunches are seated on mammillae and arranged in dorsopleural and lateral rows.

The individual rods have an intricate structure (pl. 12, figs. 1–4); instead of being striate, as supposed by Meek and Worthen in their last examination, they are furnished externally with about eighteen longitudinal, equidistant ridges, about half as high as their distance apart; the edges of these ridges are broken into slight serrations at regular intervals about equal to the distance between neighboring ridges, the highest point of each serration being toward the apex of the spine; the body of the ridge itself appears as if broken at each serration. The intervening space between neighboring ridges is equally divided by two or three exactly similar, but miniature ridges, serrated at more frequent intervals. This serration of both larger and smaller ridges, with the apparent jointing or incision of the ridges to the base at the lowest point of each serration, gives the whole spine a jointed appearance; but a close inspection of the floor of the spine itself between the ridges shows no sign whatever of any break in its perfectly smooth surface. The diameter of the spines is only about one-tenth of a millimeter, and yet it gives room for an exquisitely regular division of its periphery by seventy or more delicate ridges, every fourth one higher than the intervening, and all broken at minute intervals by uniform serrations (pl. 12, fig. 2). The preservation of these structures from carboniferous times is only less

remarkable than the occurrence, apparently so near the origin of the type to which it belongs, of ornamentation of such excessive delicacy, finish, complication and regularity. I cannot discover that dermal appendages of such delicate and specialized organization occur anywhere to-day among arthropods, unless it be when developed as scales, as in Lepidoptera, and occasionally in other groups of hexapods; some chaetopod worms have indeed hairs of curious asymmetrical structure, often very delicate and somewhat specialized. but never, so far as I can learn, to nearly so high a degree as here. The collection of these rods into fascicles is also not a little curious, and is again a feature known now in arthropods only in a few instances, such as some tufts of hairs in lepidopterous caterpillars like Orgyia; or the pencils of hair-like scales in the males of some perfect Lepidoptera, e. g. at the tip of the abdomen in Heliconia, Danais, Agrotis, Leucarctia, etc.; or in the terminal fascicles of barbed bristles in the myriapodan genus Polyxenus.[1]

There is no group of animals into which such a jointed creature as this could fall excepting worms, myriapods, or the larvae of hexapod insects. The certainty that this animal possessed a single pair of well developed legs of identical character on every segment of the body behind the first segment or head is of itself sufficient evidence to exclude it both from the worms and from the larvae of hexapod insects. No such legs or leg-like structures occur to-day in worms, and it would be idle to look for them in their ancestors of carboniferous times. The only approach to such an appearance in hexapod larvae is in the young of tenthredinous Hymenoptera, where, however, a difference of great morphological significance is found between the true or thoracic legs and the pro-legs or those attached to the abdomen; a difference based on one of the most essential underlying features of their structure as hexapods. No such difference occurs in Palaeocampa, and it is, therefore, impossible to conceive of it as the larva of a hexapod insect of any sort.[2]

In myriapods only do we find a repetition of legs of exactly similar structure on every or nearly every segment of the body;[3] by this test Palaeocampa is a myriapod; and now that we have found ancient types of this group, like the Archipolypoda, bearing huge and bristling spines arranged in series along the sides of the body, we need not be at all disconcerted at discovering this new type, with longitudinal series of fascicles of stiff rods, although we cannot restrain our surprise and admiration at their exquisite intricate structure.

Accepting Palaeocampa then as a myriapod, we may next ask what relation it bore to the myriapods of the same period and found in the same waters, and also to myriapods of to-day.

The differences between the stout, forked and bristling spines of the Archipolypoda and the close-set but spreading bunches of highly organized stiff rods of Palaeocampa appear upon the barest statement. Were it not, however, for the complicated ornamentation of

[1] See *Proc. Bost. Soc. Nat. Hist.*, XXII, 66, figs.

[2] Dr. Packard has recently remarked (*Proc. Amer. Phil. Soc.* XXI, 208)": "It seems to us that the larvae of the neuropterous Panorpidae, with their two jointed abdominal prop-legs, small head and singularly large spinose spines, arising in groups from a tubercle or mammilla, come nearer to Palaeocampa than any myriapod with which science is acquainted." This opinion, expressed since this paper was written and since the publication of my general results in the *American Journal of Science*, the author supports by no facts beyond what are implied in the above quotation. How he will account for the unquestionably close relationship of Palaeocampa, Trichiulus, and Euphoberia does not yet appear.

[3] Some smaller groups, formerly, and by some authors still, considered as belonging to the myriapods, must be excepted from this statement; their relation to Palaeocampa will be discussed further on.

the rods themselves, the distinction between the fascicles of Palaeocampa and the spines of Euphoberia would be hardly greater than that between the latter and the long hairs of Trichiulus; so that to this feature alone we cannot grant so high an importance as to another which has already been named: the presence in Palaeocampa of a single pair of legs (and consequently, to judge by analogy, of a single ventral plate) to each segment; while there are two ventral plates and pairs of legs to each segment in Archipolypoda. This is a difference of profound significance, which has separated the prevailing types of myriapods down to the present day, lying as it does at the base of the distinctions between the living chilopods and diplopods. The discovery of this type is of the greater importance because we have hitherto known nothing of any chilopodiform myriapods previous to tertiary times, unless Münster's dubious *Geophilus proavus* from the Jura possibly be an exception.[1]

In studying the Archipolypoda we necessarily confined our comparisons with modern types to the Diplopoda, because of their common possession of the fundamental feature just named; in the same way the comparisons between Palaeocampa and recent forms must be reduced to the common features or the radical distinctions which appear in studying the Chilopoda. Now although the structure of Palaeocampa can be far less perfectly known than that of the equally ancient Euphoberia and its allies, enough can be seen to point conclusively to wide and important differences between it and modern Chilopoda.

In Chilopoda, of which the modern scolopendra or centipede is the type, the body is always depressed, formed of many segments, rarely as few as sixteen behind the head, each of which is compound, being formed of two sub-segments, one of them atrophied and carrying no appendages; both dorsal and ventral plates are coriaceous, of nearly equal width, and possess no armature whatever excepting the simplest hairs, which are occasionally scattered over the surface. The larger sub-segment bears a single pair of legs, which are composed of five slender, cylindrical, sub-equal joints beyond the coxa, and armed with a single apical claw; they are attached to the interscutal membrane uniting the distinct dorsal and ventral plates of each segment and are therefore separated by the entire width of the broad ventral plates. The hindmost legs are transformed to anal stylets, while the first two pair are more profoundly transformed to subsidiary mouth parts, the first becoming palpi and the second stout nippers. The head really composed of eight primitive segments, is apparently made up of two, each of which is generally of about the same size as the body segments and as distinctly separated; the stout biting jaws, composed of the second pair of legs, spring from this second segment of the head, and the palpi or first pair of legs from the hinder part of the first cephalic segment; the anterior part of the same bears the many-jointed simple antennae.

Passing now to the comparative study of Palaeocampa, we find that its body was in all probability cylindrical, composed of a limited number of segments behind the head, and the head itself, considerably smaller than the body segments, is composed of only a single apparent segment. The legs of the segment immediately succeeding it are in every respect like those of the rest of the body, and have nothing whatever to do as auxiliary to the mouth. In this point alone we have a distinction as wide and incisive as any which separate the modern Diplopoda and Chilopoda. In the body segments we discover no trace of anything more than a simple ring without sub-division, but as the specimens indicate a coriaceous

[1] Hagen considers this a nereid worm, a suggestion I once adopted, but now find reason to question.

structure like that of modern Chilopoda, and no trace of the division between the dorsal and ventral plates can be seen in any of them, the separation of the segments into two sub-segments, as in Chilopoda, one of them greatly atrophied, could hardly be apparent did it exist. But on the other hand, as we regard the second sub-segment of Chilopoda as atrophied, we should expect to find it fully or partially developed in these creatures, which of all known ancient types are certainly the most closely related to them. Yet we find here no sign of anything more than the simplest possible, uniform, leg-bearing segments, and of a very limited number. In one feature, however, they are not so simple as in Chilopoda; for, as stated, each is provided on each side with two pairs of mammillae, supporting very large bunches of spreading rods, and the rods themselves are sculptured in a very remarkable way. This distinction between the two types, though more striking and noticeable than any other, is in itself by no means so important as the others, but may be added to the catalogue; and it must have some weight, from the total absence of appendages of any sort (beyond scattered hairs) from the dorsal plates of Chilopoda. The position of these rows of fascicles and of the legs indicates that the ventral plates were only a little narrower than the dorsal, and probably of about the same extent as in the Archipolypoda; in this respect they would not differ to any important degree from modern Chilopoda. The legs were different in form, but their poor preservation in the only specimen in which they have been seen prevents anything more than the mere statement of the following difference: while the legs of Chilopoda are invariably horny, slender, adapted to wide extension and rapid movement; those of Palaeocampa are fleshy, or at best subcoriaceous, very stout and conical, certainly incapable of rapid movement, and serving rather as props.

These differences, which underlie every part of the body that is preserved in Palaeocampa, show that while the general accordance of grand features compels us to look upon Palaeocampa as a precursor of the Chilopoda, we must separate it from them in the same way as we separate the Archipolypoda from the Diplopoda. For such a group the name of Protosyngnatha is proposed, indicating its ancestral relations to the Chilopods, or Syngnatha, as they were called by Latreille.

There are, however, two aberrant groups of living animals more or less closely related to myriapods, and placed with them by some authors, with which also we should compare Palaeocampa. The first of these is Peripatus, our knowledge of which has been so much increased of late years, and especially by the researches of Moseley.

In external appearance Peripatus resembles an annelid, but is furnished with a pair of long, jointed antennae, and with numerous fleshy, tapering legs, each armed at tip by a pair of claws; the legs, set wide apart, are obscurely jointed, the joints being perceptible only at the extreme tip and on the apical half of the inner side, above which are the large elongated openings into the nephridia. The entire body is of a leathery texture with no external sign of segments, or of the separation of the head from the rest of the body, except the appendages: namely, the legs, the nephridia opening on the legs, and the ordinary appendages of the head. The same is true when the internal structure of the body is examined, for neither in the disposition of the muscles nor of the tracheal apparatus does it appear that one could judge whether a pair of legs represented one or more segments of the body; even in the nervous system it is only indicated by a small ganglionic swelling next each pair of legs. The tracheae are like extended cutaneous glands, independent of

one another, and scattered over the body, and the longitudinal muscles show no regular segmental breaks. This weakness of segmental divisions is nowhere paralleled among hexapods, arachnids or myriapods, and is an indication of very low organization among arthropods generally. The number of legs indicates from 15 to 35 segments in the body, according to the species. The first pair, as they are developed in the adult, are functionless as legs, and are situated (in the specimens I have examined — a South American species, probably *P. Edwardsii*), midway between the antennae and second pair of legs, and not only outside of, but at some distance from the mouth parts, so that the latter are not furnished with auxiliary appendages borrowed from a segment behind the first, as in chilopods; this is further proven by the development of these parts in the two groups. The body is profusely covered above with corrugated papillae, without regular distribution.

From this it will appear that Palaeocampa differs in many essential features from Peripatus, and in most at least of these shows a higher organization. The segments are well separated from one another, and the head is distinctly marked. The number of segments is much less, and each bears clusters of appendages of a highly specialized character. Although no spiracles are present in the remains we have of Palaeocampa, it is clear that respiration must have been effected through linearly disposed openings; since the muscular or mechanical requirements for the movement of a completely segmented body (especially if, as in Palaeocampa, the segments bear a heavy armature), forbid the miscellaneous distribution of tracheae, and demand a well-developed system with the same linear arrangement which we find in the armature. The best that can be said of the respiratory apparatus in Peripatus is that the tracheal bundles show a tendency toward "a concentration along two sides of the body, ventral and lateral." The possession, however, in each type, of a single pair of legs to every segment behind the head indicates an affinity which cannot be overlooked, and which is the more interesting since one of the types is very ancient and the other is universally looked upon as an existing survivor of an ancient type. The form of the body and of the fleshy legs is also similar, but these are minor points; and however close the agreement between these forms, we cannot look upon Palaeocampa, with its undoubtedly well-developed tracheal development, as in any sense the genetic predecessor of Peripatus, for the generally distributed tracheal apertures of the latter could not have developed from a serial disposition, without a degradation of type which, as Moseley points out, many other features combine with this to disprove. It may also be added that while the legs of Palaeocampa are poorly preserved in the only specimen which gives a side view, the presence of nephridial openings, of such an extent and in such a place as in Peripatus, could hardly fail of detection, and they are entirely absent. The presence of these in Peripatus is one of the marks of their inferior organization, or rather of their alliance to an inferior type, the annelids.

The other aberrant group which we must specially notice is Scolopendrella, placed at first among Chilopoda, but recently shown by Ryder and Packard to differ from them in very important features, in some at least of which it agrees with Palaeocampa. The researches of these naturalists, as well as the earlier observations of Menge, clearly prove that it must be separated from the myriapods altogether, and that it is certainly provided with many points of affinity to the Thysanura. Ryder suggests for it an independent place between the Myriapoda and Thysanura under the name Symphyla. Packard, with

better reason, would place it within the Thysanura, under which head he would also include the Collembola and Thysanura proper, or Cinura, as he terms them.

Scolopendrella, as these authors point out, differs from the Chilopoda in that the appendages of the segment behind that furnishing the mouth-parts proper do not serve as auxiliary organs for manducation, but are developed, like those of the succeeding segments, as legs, while the mouth parts resemble those of Thysanura, and differ from those of Chilopoda; indeed the whole head is decidedly thysanuriform; the legs are provided with a pair of claws, and the terminal segment bears a pair of caudal stylets with a special function. Besides these points the possession of a collophore is distinctively thysanuran, and the position of the stigmata, between the legs, is different from the position they uniformly maintain in Chilopoda, while it only adds to the great irregularity of place seen in Thysanura. On the other hand, the identity of form in the thoracic and abdominal segments, the full development, upon the abdominal segments, of jointed legs like those of the thoracic segments, and the occasional alternation of leg-bearing and apodal segments in the abdomen, are striking marks of its real affinity to the chilopods. Abdominal appendages, homologous with legs, but unjointed, do, however, occur in Thysanura to a greater degree than in other hexapods, so that we can hardly refuse to admit these polypodous creatures as lowest members of the sub-class of insects proper, although they are the only non-hexapodal type.

Now the separation of the head and its appendages from those of the next succeeding segment distinguishes Palaeocampa from the chilopods in the same way as it does Scolopendrella; so, too, the segments behind the head in Palaeocampa and Scolopendrella, alone of all arthropods in which the head is thus clearly separated, agree in showing no distinction whatever between what may be looked upon as thoracic and what as abdominal, whether in the form of the segment itself, or in the appendages of the segments. These are certainly fundamental points, but when we have mentioned them we have reached the end of all possible affinities, or points of resemblance, unless we may consider the minute structure of the rods in the fascicles of Palaeocampa parallelled by the well-known delicacy of organization of the scales in some Thysanura, though they do not exist in Scolopendrella. The limited number of abdominal segments might be looked upon as a further point were it not that the number is even less than in Scolopendrella or in the Cinura; and that the Pauropida among diplopod myriapods have in some instances even a still smaller number. On the other hand, the character of the legs, the apparent absence of a double claw at their tip, the peculiar armature of the fascicled rods, which forms so striking a feature in Palaeocampa, the want of any caudal stylets, and the complete uniformity of the segments of the body unprovided with distinct dorsal scutes, distinguish Palaeocampa not only from Scolopendrella but from all Thysanura whatever; the general form of the body, too, is altogether different from anything occurring there, even its cylindricity being foreign to the Thysanura, excepting in their highest types among the Collembola. It seems, therefore, clear that the points of affinity between Palaeocampa and Scolopendrella, with the single exception of the separation of the head and its appendages from the body, are precisely those in which Scolopendrella is chilopodan, and that the assemblage of features which our fossil presents are therefore chilopodan rather than thysanuran.

Regarding Palaeocampa then as a myriapod, though of a type very distinct from any

known, whether living or fossil, we are brought face to face with two remarkable and somewhat parallel facts: First, that *in this ancient myriapod*, as old as any with which we are acquainted, carrying us back in lead as far as any traces of wingless tracheate arthropods have been found, and, therefore, presumably not far from the origin of this form of life upon the earth, *we find dermal appendages of an extraordinarily high organization*, more complicated, as we have pointed out, than anything of the sort found in living arthropods, excepting the more varied but not more exquisite scales of several orders of hexapods; a form of appendage which it would seem, on any genetic theory of development, must have required a vast time to produce, but which we now seem to find at the very threshold of the apparition of this type of arthropod life.

Second, that *at this early period*, in marked contrast to what we find in other groups of articulated animals, *the divergencies of structure among myriapods was as great as it is to-day*. This is the more surprising because we possess only imperfect remains of a few types, and yet from what we already know of the Archipolypoda on the one hand, and of the Protosyngnatha on the other, they are found to differ quite as much as the Diplopoda and Chilopoda, and in points fully as important as those which separate so sharply these great modern groups. Whether they are to be looked upon, one as the ancestor of one, the other of the other, of these modern groups, is another question. It would certainly be reasonable to consider the Archipolypoda as the common ancestors of both the Chilopoda and Diplopoda; and possibly on the Protosyngnatha as the descendants on one line of a primitive type which, on another line, has retained its integrity up to the present day in Peripatus (and on possibly a third line has reached Scolopendrella); while on that which produced Palaeocampa it has not, so far as we know, survived the carboniferous epoch.

With the facts of structure of ancient and modern types now before us, we are compelled, on any genetic theory, either to presume a great acceleration of development in earlier times or to look for the first appearance of myriapods at a vastly remoter epoch than we have any reason to do from the slight hints in the rocks themselves — a period so remote as to antedate that of winged insects, which are now known from rocks older than any which have yielded remains of myriapods.[1] In a memoir on Devonian insects,[2] I showed the probability, on developmental grounds, that some of the carboniferous insects, "together with most of those of the Devonian, descended from a common stock in the lower Devonian or Silurian period; and that the union of these with the Palaeodictyoptera (of the carboniferous), was even further removed from us in time." The structural relations of myriapods and hexapods render it probable that the former preceded the latter; and in complete accordance with this expectation, the structural relations of the oldest fossil myriapods indicate their apparition at a period earlier than that to which the winged insects are hypothetically assigned. This would compel us to consider the earlier type as aquatic, for which we have presumptive evidence in the structure of the Euphoberidae, and renders it all the more surprising that the penetrating researches of the last thirty-seven years, since the first carboniferous myriapod was discovered, have not yielded the slightest trace of fossil myriapods below the Coal measures.[1] This discrepancy between fact and hypothesis should never be lost sight of, and should stimulate to more searching

[1] This was written before the publication of Mr. Peach's discovery of myriapods in the Old Red Sandstone of Scotland.

[2] Anniv. Memoirs Bost. Soc. Nat. Hist., 1880.

investigations particularly of those articulates of the older rocks whose affinites have not been satisfactorily settled.

It only remains to give descriptions and refer to illustrations of the species of the two groups whose general affinities have been discussed.

Suborder ARCHIPOLYPODA.

Family Euphoberidae.

Trichiulus nov. gen. (θριξ, ιωλος.)

Segments from three to four or five times broader than long, covered closely with tolerably large papillae, which are arranged in definite series both longitudinally and transversely, and support long flexible hairs, which together form a sweeping mass covering the whole body.

These points will serve abundantly to distinguish this genus from the other Archypolypoda described in my previous paper on the subject. They are derived from the study of all the species described below, no one of which, however, presents them all; only one of them shows the sweeping mane of hair enveloping the whole creature; the others either have no hair preserved at all, or at most vague appearances of a mat of hair next the integument; on the other hand the specimen showing the hair so well shows nothing of the papillae which (doubtless) bear them, and which show to perfection in most of the other specimens.

The number of segments appears to vary considerably, from about 20 or more in one species to 35 or more in another; the form appears to be nearly the same in all, the body being much larger at the front than at the hinder extremity, and tapering pretty steadily toward the tail; in one, however, which is fragmentary, no sign of this change is shown. The head end also tapers, but only just next the head itself so far as known, in this respect differing from other Archipolypoda. The head itself, too, joins in this rapid diminution entirely, instead, as in most other Archipolypoda, of being considerably larger than the segments just behind it; its outline, however, is perfectly preserved in only a single specimen, so that this statement should not be taken as absolute. The various species differ from each other in the form in which the body varies in proportion, in the number and relative proportions of the segments and in the frequency and arrangement of the papillae or tubercles from which the hairs originate.

Trichiulus villosus nov. sp.

Pl. 13, fig. 2.

Body composed of more than thirty segments which vary from two to three times as broad as long, being broadest in the stoutest part of the body; it is broadest from the third to about the tenth segment and then tapers very regularly to less than half the diameter at the hinder extremity; the anterior extremity of the body in front of the third segment tapers very rapidly and considerably, the head being only a little larger than the tail — a point seen best in the reverse of the specimen drawn and not appearing on the

plate. The whole surface of the body upon both sides, as it lies coiled in an open spiral, is covered with a thick mat of rather fine hairs which appear to be two or three times longer than the diameter of the body. Two or three pairs of short and slender tapering legs can be seen (not given on the plate) depending from the anterior segments; they are scarcely half as long as the diameter of the segments. The length of the fossil if unrolled would be 20 mm.; its greatest diameter is 2.1 mm. The specimen is from the nodules of Mazon Creek and was obtained by Mr. P. A. Armstrong.

Trichiulus nodulosus, nov. sp.

Pl. 13, figs. 1, 3.

Two specimens at hand are referred to this species, though each is so fragmentary that the determination is uncertain.

One of them (pl. 13, fig. 1) represents a dozen segments of the entire width of the creature, being apparently only a fragment of the larger end; it does not taper, and the segments are about four times as broad as long, each furnished with two transverse series of equidistant, small, rounded warts, apparently the bases for appendages of some sort; the series are also equidistant so that the warts are sprinkled over the surface in a very regular fashion, like a checkerboard, in both longitudinal and transverse rows. Each series on the same segment is separated from the other by a transverse depression a little shallower than the sulcation between the segments. The warts are about 1.25 mm. distant from each other and slightly less than half a millimeter in diameter. The length of the fragment is 29 mm., and its breadth 9.25 mm. No appendages of any sort are to be seen; but next the margin in some places are faint signs of delicate hairs, and the discoloration of the skin in the neighborhood may indicate its previous extent.

The other specimen (pl. 13, fig. 3) is longer, but by the method of preservation and the cleavage of the nodule it only shows a portion of the breadth, and neither edge, so that no appendages can be seen, nor any hairs. The same arrangement of warts or tubercles can be seen, rendering it probable that it belongs to the same species as the other. These wartlets are at the same distance apart as in the other specimens, and the series are similarly arranged, the sulcations between the segments being slightly deeper than those between the transverse series of a single segment; but the wartlets appear a little sharper or more conical. The length of the fragment is 45 mm. and its extreme breadth 4.5 mm.; the segments can only be faintly seen over a portion of the fragment, but there were probably about twenty in this piece, which does not seem to reach either extremity. Both specimens are from Mazon Creek and were obtained by Mr. P. A. Armstrong, and are in his collection.

Trichiulus ammonitiformis, nov. sp.

Pl. 13, fig. 4.

Although the single specimen found presents few tangible characters, it differs so much from the others that it seems worth while to make it public. It is of much greater size and is coiled into a slightly open spiral, and being preserved on a side view has a cursory resemblance on the stone to a fossil ammonite. If unrolled it would measure about 115

mm. in length and its extreme breadth is 14 mm. The head end is broken badly but enough is preserved to show that it tapered anteriorly, the largest part of the body being probably the end of the anterior third; beyond this the body tapered gently to very near the tail, but then diminished very rapidly in size, the tip, however, being rounded; a little before the rapid diminution in size the diameter is 9 mm. There seem to have been about thirty-five segments to the body, about four times as broad as long on the average, not very much arched and least so along the upper portion, where, at least in the fossil, the surface is almost completely flat and shows scarcely a sign of the divisions of the segments. In certain parts of the fossil there are indications of minute tubercles as if for the support of hairs, but they are obscure and would not have been noticed but for their occurrence in the preceding species. There is, however, along the outer edge an exceedingly faint indication of a delicate mat of very fine hairs, where the surface of the stone, as in T. villosus, is decidedly darker than elsewhere. This specimen also was found by Mr. P. A. Armstrong in the nodules of Mazon Creek.

Suborder PROTOSYNGNATHA.

Palaeozoic myriapods, with a cylindrical body, the head appendages borne upon a single segment; each segment behind the head composed of a dorsal and ventral plate of equal length and, probably, of subequal breadth; the dorsal at least somewhat broader than the ventral, occupying the greater part of the sides of the body, and supporting several longitudinal rows of clustered needles; the ventral plates occupying the entire ventral portion, each bearing a pair of widely separated, stout, fleshy legs, i. e., one pair to each segment of the body behind the head; spiracles probably present in a definite longitudinal row.

Genus Palaeocampa (παλαιός; κάμπη.)

Palaeocampa, Meek and Worthen, Proc. Acad. Nat. Sc. Philad., 1865, p. 52 (1865); — Ib., Geol. Surv. Ill., 2 : 410 (1866).

Desmacanthus, Meek and Worthen, Geol. Surv. Ill., 3 : p. 565 (1868).

Head corneous with no armature. Body coriaceous, coarsely shagreened, composed of ten segments furnished on each side with two rows, dorsolateral and lateral, of fascicles of needle-like spines, one to a segment in each row, placed upon tubercles near the front of the segments; the fascicles are cylindrical at base, the needles diverging only a little; each needle tapers very slightly, is blunt at tip, and very regularly divided by longitudinal serrated ridges. Legs stout, subequal, about as long as the width of the body, tapering and pointed.

Palaeocampa anthrax, Meek and Worthen.

Pl. 12.

Palaeocampa anthrax, Meek and Worthen, Proc. Acad. Nat. Sc. Philad., 1865, pp. 52-53, (1865); Palaeont. Ill., Vol. 2, pp. 410-411, pl. 32, fig. 3 (1866); — Ib., Vol. 3, p. 565 (1868); Scudder, Geol. Mag., Vol. 5, p. 218 (1868). Figured also in Packard's Guide to Study of insects, fig. 68 on p. 78.

Four specimens of this species have been examined, two of them belonging formerly to Mr. J. C. Carr, of Morris, Ill., and received for study from him, but now in the collection of Mr. R. D. Lacoe, of Pittston, Penn.; a third received from Mr. Lacoe and numbered 1851 in his collection; the fourth obtained by Mr. F. T. Bliss, of Morris, Ill., and in my own collection; all of these are admirably preserved and show both relief and counterpart. Both of Mr. Carr's specimens are preserved from above and have the fascicles spread regularly upon either side of the body. In one (pl. 12, fig. 7), which has the head end as well as the opposite completely fringed with spines, the general cursory resemblance of the whole to the caterpillar of an Arctian is very striking. The rods of the fascicles of the first and second body segments and especially of the first are considerably shorter than those of the succeeding segments, those of the first projecting forward over and concealing the head; in the same way those of the last segment make a complete fringe around the posterior extremity of the body. The fascicles are more readily seen on this than on the other specimens to emanate from tubercles, which are conical and apparently (here at least) higher than their basal breadth. The fascicles are longer than the width of the body, and their most divergent rods are about at right angles to each other. The length of the body in this specimen is 33 mm.; or, with the rods, 40.5 mm.; the width of the body is 5.5 mm.; or, with the rods, 17 mm. The longest rods are 6.5 mm. long.

The second specimen of Mr. Carr's collection (pl. 12, fig. 6) is about the same size as the last, the body measuring 34 mm. by 5 mm.; or with the rods 40.5 mm. by 15 mm. The rods in the fascicles are, however, considerably less divergent and trend a little backward giving them a more bunchy appearance; those of opposite sides of the same fascicle rarely diverge more than 55°; the rods themselves appear here to be usually a little longer than in the first specimen though the longest are of the same length, and to be seated on tubercles which are stouter and less elevated, but this may be merely an appearance due to the way in which the specimen is preserved. The relation of the rods of the first and second body segments, and of the last segment to the others so far as their size and distribution is concerned, is the same as in the previous specimen; but those of the anterior segments are not directed forward, but on the first segment backward and on the second laterally so as to leave the head nearly uncovered. This appears as a rather small, transversely oval, rounded mass, about twice as broad as long, and only about half as broad as the body; neither eyes nor antennae can be made out.

The specimen obtained by Mr. Bliss (pl. 12, fig. 8) is slightly smaller than the others, preserved on a side view, and arcuate instead of straight. If extended, the length of the body would be 33.5 mm. and its height 4.5 mm.; or, including in the height both spines and legs, 13.5 mm.

The rods in the fascicles are even less divergent than in the last mentioned specimen, rarely exceeding 40° between opposite rods of the same fascicle (pl. 12, figs. 5, 9). There is also less indication here of any tubercles at the base of the fascicles, and those of the first and second segments although shorter than the others are not noticeably so, and the first are very nearly as long as the second; the longest spines are about 6 mm. long. In this side view the head again appears, not separated by any sharp line of demarcation from the segment behind, but considerably smaller than the body, higher than long, rather flattened in front, and with an inferior basal projection of a conical form; no eyes nor appendages

can be made out. The legs are about as long as the width of the body, stout, slightly smaller at the immediate base than just behind it, tapering beyond the middle and with increasing rapidity nearly to the tip, the last joint (apparently) being equal; this is hardly shown in the plate, and does not show on all the legs in the fossil, the apices of these members being exceedingly vague; but in a few instances it appears to be somewhat clearly the case, and a slight appearance of it shows on the leg of the seventh body segment in the plate; on the reverse of the specimen drawn it appears even more plainly on the legs of the second, fourth, and fifth segments. This apical joint appears as such simply by the contour of the leg, but no other joints can be determined in the same way; indeed, the legs themselves are only pale shadows, and they are traversed by numerous darker bands which seem to indicate joints, but they are rather more numerous than one would expect, and a little irregular, so that little can be definitely affirmed concerning them; taking them, however, where they appear most regular and best defined and connecting with them the two or three transverse rows of minute granulations, that seem to encircle each joint with some regularity, and it would appear as if there were about five equal joints in the leg besides the smaller non-tapering apical joint. The length of the legs appears to be slightly greater in the middle of the body than at the two extreme ends; the middle legs are 4.5 mm. long (of which the apical joint is 0.75 mm. long) and 1.4 mm. broad in the middle, the apical joint being 0.5 mm. broad. No sign of claws can be seen.

The fourth specimen, received from Mr. Carr after the others had been studied and figured, differs but slightly from the first two. It exhibits the animal expanded in a straight line, but a little on one side so that only the spines of one side show in full. The spines of the first and second segments are lateral; but, nevertheless, no head is visible, being, perhaps, buried in the stone. The spines, especially individual ones, are of unusual length, the longest being 8.5 mm. long; they diverge in the fascicles less, rarely exceeding a divergence of 35° and usually not exceeding 20°. The fascicles of the hinder half of the body trend slightly backward, increasingly so toward the tip, but they are almost exactly at right angles to the body on the front half. No legs are visible. The body is 32.5 mm. long, or including the spines which fringe the posterior end 35 mm. (perhaps more, for the end of the stone is reached); the width of the body is 6.5 mm.; or, including the mass of spines (on one side only) 12 mm.; or, including the longest spines, 14 mm.

These specimens, which agree so closely in size, are considerably larger than the first specimen found, upon which the description of the species was based by Messrs. Meek and Worthen; judging by their figure and description, that specimen if extended would measure 23 mm. in length; or, inclusive of the rods, 32 mm.; and 3.5 mm. in breadth; or, including the rods, 8.5 mm. To judge from the arcuate position and the absence of rods from the under surface, it probably presented a side view or one partially dorsal; but the authors say that neither head nor feet can be seen; the distribution of the rods is somewhat like that of our fig. 7, that is they are considerably divergent, but the figure gives no sign of any tubercles to which they are attached; the general resemblance of the whole animal is so close that no doubt can exist that it is of the same species as those now figured. The specimen has been lost by a fire.

In a later volume of the Illinois reports the original authors of the species describe another specimen from the same place, only mentioning, however, the rods, which they

say are much better preserved, and which for the first time they discover to have longitudinal markings.

A careful study of the four specimens seen by me show that there is no variation in the character of the rods in different individuals beyond what is found on one and the same individual; and these may now have a particular description, which from their remarkable structure they well merit.

The rods (pl. 12, fig. 1) are straight, rigid, needle-shaped bodies, 5–6.5 mm. long and about 0.075 mm. in diameter, imperceptibly tapering, so as to be at tip fully three-quarters as large as at base, and terminating abruptly, apparently with a broadly rounded tip. It seems to be composed (pl. 12, figs. 2, 4) of an inner core, about nineteen-twentieths (in diameter) of the whole, and a shell upon which very delicate markings are traced; the shell readily peels from the central core and may thus be mounted in balsam and examined by transmitted light under the microscope (pl. 12, fig. 3), when the distinctions between the parts may be readily seen.

Two schematic drawings are given to show the minute markings of the shell. Pl. 12, fig. 4, represents a diagrammatic view of the cross section of a rod, magnified 1000 diameters, and fig. 2 represents an oblique view on the same scale. The rods are thus seen to be longitudinally furnished with about eighteen mainridges, as straight as the rod itself, equidistant from each other, rounded at the top and with steeply sloping sides so as to be scarcely broader at base than in the middle and of equal basal breadth and height; these ridges are divided at subequal distances by notches, or rather they are made up of serrations, the highest end of the serration next the tip of the spine; the greatest increment in the height of the serration is in its basal fourth, calling the base the end toward the base of the spine; and the extreme height is about double the least height; in the same basal fourth occurs the greatest increment in breadth, for each serration increases also in this dimension toward its highest point, so as to be about one-fifth broader at apex than at base. To increase the distinction of the serration, there appears at the base of each to be a closed joint, separating each one from its neighbors. Although at first these serrations appear to be divided off from each other with remarkable regularity, and at a distance apart averaging about .0133 mm., a little observation shows that this is not strictly true; and a measurement of nineteen successive serrations on the same ridge showed the following series as given in millimeters: .0144, .0135, .0182, .0144, .0135, .0115, .0154, .0115, .0173, .0135, .0135, .0115, .0144, .0135, .0125, .0115, .0077, .0115, .0135; another shorter set on another spine gave the following series: .0154, .0115, .0154, .0192, .0135, making the average a very little less.

Between every pair of these ridges are generally three, sometimes two, exactly similar but minuter ridges about one-eighth the height of the others, and also of equal height and width but apparently a little more triangular in cross section; these likewise are broken up with serrations, apparently resembling the others closely but so minute that the proportions cannot be so closely studied as to be quite sure of this; they certainly differ in that the serrations are proportionally longer, there being but two or three to each serration of the larger ridges, as shown in pl. 12, fig. 2. In this drawing based on instruction given the artist from my studies of numerous fragments, and by his examination of the specimen represented in pl. 12, fig. 3, he has misunderstood a single point, in bringing the

larger ridges nearer together in some parts of the same cross section than in others, and placing between them only two instead of uniformly three minor ridges. In all the fragments I have seen there are either two or three (almost universally three) minor ridges between every pair of larger ridges on every part of the same fragment. It is possible that in the slight tapering of the spine two larger ridges coming nearer together compel the union of two adjacent minor ridges and reduce the number to two instead of three, so that in one portion of a spine one may find two and in another three minor ridges between every pair of larger ones; but this I have not seen, and can only say that while three smaller ridges usually appear in every interspace between adjoining larger ridges, the number is sometimes only two. Otherwise the proportions of these ridges and serrations to each other is very well shown in fig. 2.

All the specimens found came from the ironstone nodules of Mazon Creek, near Morris Illinois.

Explanation of Plates.

PLATE XII.

[All the figures represent Palaeocampa anthrax.]

Fig. 1. A spine $\frac{3}{1}$ to show its appearance under an ordinary strong lens, showing an apparently striated surface. Drawn by Katherine Peirson.

Fig. 2. An oblique view of a fragment of the surface of the spine $\frac{10}{1}$, showing the serrations of the larger and smaller ridges and their relations to each other; three of the minuter ridges should have been shown in every interspace, but in two of them only two are given. The figure is schematic. Drawn by J. Henry Blake.

Fig. 3. A fragment drawn from nature of the shell of a spine $\frac{2}{1}$, as seen with a half-inch objective. Drawn by the same.

Fig. 4. Schematic view of a cross section of the shell of the spine, showing the relations of size and position of the spine, the shell and the two kinds of ridges, $\frac{10}{1}$. Drawn by S. H. Scudder.

Fig. 5. One of the clusters of spines of fig. 8, $\frac{1}{1}$. Drawn by Katherine Pierson.

Fig. 6. One of Mr. Carr's specimens, showing the head, above, $\frac{1}{1}$. Drawn by the same.

Fig. 7. The other of Mr. Carr's specimens, $\frac{1}{1}$. Drawn by the same.

Fig. 8. The specimen with legs, found by Mr. Bliss, $\frac{1}{1}$. Drawn by the same.

Fig. 9. The same cluster of spines shown in fig. 5, $\frac{1}{1}$. Drawn by the same.

PLATE XIII.

Fig. 1. *Trichiulus nodulosus*, $\frac{2}{1}$. From the collection of Mr. P. A. Armstrong, No. 7. Drawn by Katherine Peirson.

Fig. 2. *Trichiulus villosus*, $\frac{2}{1}$. From the same collection, No. 18. Drawn by the same.

Fig. 3. *Trichiulus nodulosus*, $\frac{2}{1}$. From the same collection, No. 52. Drawn by the same.

Fig. 4. *Trichiulus ammonitiformis*, $\frac{2}{1}$. From the same collection, No. 2. Drawn by the same.

The remaining figures belong to the next memoir.

The Species of Mylacris, a Carboniferous Genus of Cockroaches.

MYLACRIS was first suggested by me as a name for a genus of paleozoic cockroaches in 1868, but its full definition from other cockroaches was not given until eleven years later in my memoir on paleozoic cockroaches, when five species, two of them new, were fully characterized and figured. It is the principal genus of the tribe Mylacridae, the distinctively American group of ancient cockroaches, and by the facts known three years ago appeared to be confined to the lower or middle coal measures. Through the indefatigable efforts of Mr. R. D. Lacoe of Pittston, Penn., whose explorations of the coal measures of the United States have yielded better results for fossil insects than those of any other person, I am enabled in this paper to double the number of species, besides giving additional information concerning an imperfectly known species, nearly all the additional forms coming from the coal measures of Pennsylvania; not all, however, as before, from the lower and middle series, but also from the upper coal measures, showing that Mylacris has the same range as Lithomylacris. The species of the genus may be distinguished by the following table.

Key to the Species of Mylacris.

1. Externomedian veins superior or apical. 2
1. Externomedian veins inferior or apical. 7
2. Externomedian veins distinctly superior. 3
2. Externomedian veins rather apical than superior. 5
3. Apex of wing falling in the middle line, the costal and inner margins being about equally arcuate. 1. *M. bretonensis.*
3. Apex of wing falling below the middle line, the inner margin being much straighter than the costal. 4
4. Costal margin curving inward on the basal third of the wing. 7. *M. anthracophilum.*
4. Costal margin bent abruptly inward at extreme base of the wing with no previous inward curve. 8. *M. priscovolans.*
5. Externomedian area occupying the apex of the wing. 2. *M. Heeri.*
5. Externomedian area falling wholly below the middle line of the wing. 6
6. Mediastinal veins comparatively few and distant; scapular vein forked at base. 3. *M. antiquum.*
6. Mediastinal veins numerous; scapular branches all emited from a single main branch. 4. *M. lucifugum.*
7. Costal much more curved than inner margin. 8
7. Costal and inner margin similarly and symmetrically curved. 9
8. Costal margin very strongly curved in the mediastinal area, which scarcely reaches to the middle of the wing. 6. *M. carbonum.*

8. Costal margin gently curved in the mediastinal area, which extends considerably beyond the middle of the wing. 5. *M. pennsylvanicum.*

9. Combined mediastinal and scapular areas as broad at the base as beyond. 9. *M. Mansfieldii.*

9. Combined mediastinal and scapular areas much broader near the middle of the wing than at the base. 10. *M. ovale.*

1. **Mylacris bretonense.**

Blattina bretonensis Scudd., Can. Nat., VII, 271–272, fig. 1. Figured also in Dawson's Acadian Geology, Suppl. to 2d ed., p. 55, fig. 5.

Mylacris bretonense Scudd., Mem. Bost. Soc. Nat. Hist., III, 41–42, pl. 5, fig. 1.

Sydney, Cape Breton.

2. **Mylacris Heeri.**

Blattina Heeri Scudd., Can. Nat., VII, 272, fig. 2. Figured also in Dawson's Acadian Geology, Suppl. to 2d. ed., p. 55, fig. 6.

Mylacris Heeri Scudd., Mem. Bost. Soc. Nat. Hist., III, 43–44, pl. 5, fig. 11.

Sydney, Cape Breton.

3. **Mylacris antiquum**, nov. sp.

Front wing. The inner edge is imperfect and a little of the tip is gone, but the rest of the wing, which is remarkable for its approach to Lithomylacris, is pretty well preserved. The mediastinal and scapular areas together certainly occupy the major part of the wing and the externomedian area expands but very little apically; the wing, however, is broad and full and closely approximates *M. Heeri*. The humeral lobe is full and angular, with the corner well rounded off, the costal margin scarcely convex beyond the base; the whole wing was probably a trifle more than twice as long as broad. The veins originate from a little below the middle of the base and curve upward at their start until they reach the middle, when they are very nearly straight. The mediastinal area is very large indeed with few and rather distant veins, forking once near the base, reaching the end of the middle third of the wing. The scapular area occupies the rest of the upper half of the wing, the vein itself dividing close to the base, the forks again dividing near together in the basal third of the wing, with a still further branching of nearly every ramus half way to the tip, and again of some near the tip; these branches are all straight except the lowest near the tip which turn slightly upward, thus throwing all the extremities of the branches above the middle of the tip and giving the scapular-externomedian interspace a slight sinuosity. The externomedian vein is straight and forks first just before the middle of the wing; each of its branches dichotomizes more or less but without much further divarication, so that the area is more crowded with veins than those above. The internomedian area is tolerably large, notwithstanding the considerable size of the anal area, for it reaches well toward the extremity of the inner margin of the wing, sweeping thither in a somewhat sinuous curve with unusually longitudinal veins; in the single specimen the vein has but three branches, the middle one forked near its origin, the others simple. The anal

area is very large, the anal furrow being very pronounced, broadly curved and extending far outward in a somewhat unusually longitudinal course nearly to the middle of the wing; the anal veins appear to belong to two sets opposed to each other, an upper with inferior, and a lower with superior branches, all very longitudinal, nearly parallel with the costal margin and nearly all simple; the upper area is just as longitudinal as the lower and quite independant of the course of the furrow, leaving a large sub-triangular space near the most strongly curved portion of the furrow quite devoid of veins.

The species is a very large one, the largest of the genus yet known; the fragment of the wing being 33 mm. long (its probable entire length 37 mm.) and its breadth about 17.5 mm.; or, the breadth to the length as about 1 : 2.1. All the veins are in very distinct relief, with the interspaces deeply sunken between them; there seem to be no surface markings. The specimen is curiously preserved, the edge of one-half of the nodule falling longitudinally across the inner margin, following nearly the mid-space between the two sets of anal veins as marked by the light belt in the larger figure we shall hereafter give; all the parts below this, together with the opposite left wing (given in the other figure) lie over the edge on the back side of the stone, the plane of which lies at an angle of about 45° with that showing the main portion of the right wing, and forms the present surface of the nodule; the other half of the nodule shows the counterpart of our larger figure.

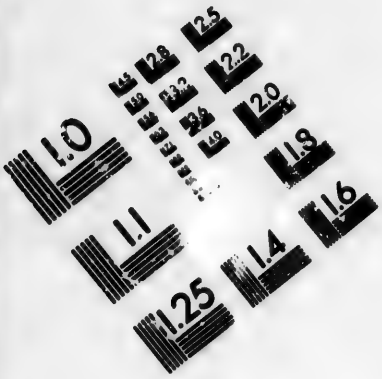
This species is, as we have said, most nearly allied to *M. Heeri* in the great amount of space occupied by the mediastinal and scapular areas as well as by the course of the anal furrow, and apparently by the peculiarities of the anal veins. It is, however, a very much larger species than it (or any other species of Mylacris), and the peculiar dichotomous division of the scapular vein separates it at once from every species known, and it is nearly as peculiar for the longitudinal course and sinuous sweep of the internomedian veins. In the general positions occupied by the different areas, it resembles *M. lucifugum*, with which it better agrees in size; but it disagrees with it, not only in the peculiar division of the scapular vein, but in the less crowded and more regular veins of the mediastinal area, and the more rounded humeral lobe.

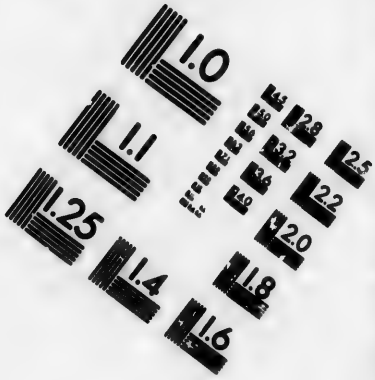
The specimen comes from the famous locality of Mazon Creek, and is in the collection of Mr. R. D. Lacoe under the number 2036. Having been received after the plate was engraved, figures of the species will be given on some future occasion.

4. **Mylacris lucifugum** nov. sp.

Pl. 13, fig. 8.

Front wing. The basal portion, excepting the anal area, is preserved, but at least the apical third is gone. There is a rectangular rounded shoulder of considerable extent, minutely marginate, but without neuration; the basal, preserved half of the costal margin is straight, but at the extremity of the fragment begins to curve slightly, and this with the direction of the veins makes it probable that beyond this it was gently arcuate. the tip rounded and the inner margin nearly straight. The mediastinal veins are confused at their base by vegetable remains and may be inaccurately given in the plate, but they apparently occupy the area marked, or more than one-third of the fragment and nearly





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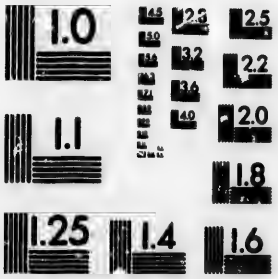

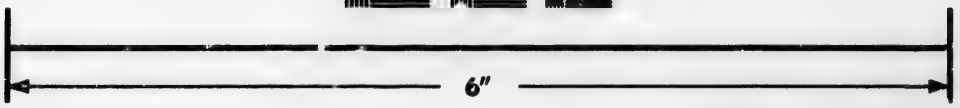

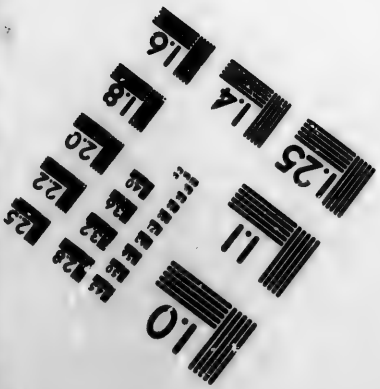

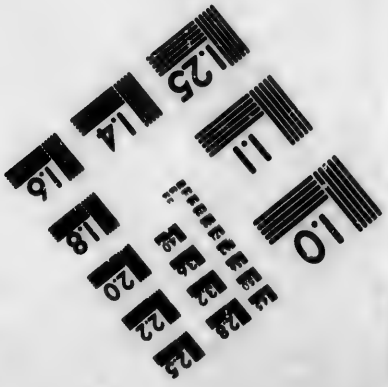

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one-fourth of the wing; they diverge from a point before the base of the wing and are very straight and fork somewhat — just how much the preservation does not permit one to say. The scapular vein passes in a very straight course down the middle of the wing with a slight obliquity from above downwards in passing distally, but probably terminates at the apex; it emits a number (4 or 5 are preserved in the fragment) of straight, approximate, so far as we can see simple, branches parallel to the mediastinal veins. The externomedian vein is slightly arcuate, but otherwise parallel to and equidistant from the scapular, forks before the middle of the wing, each of these branches again forking, but not widely; in the part lost they probably branch more but can hardly occupy much space on the border. The internomedian vein is gently and uniformly arcuate and probably terminates where the inner margin begins to curve considerably toward the tip; in the basal half of its course it emits four or five simple, occasionally simply forked branches, more faintly traced than the other veins of the wing and which curve gently in an opposite sense to the main stem. The anal furrow is slight and faintly impressed, gently and regularly curved throughout, terminating probably at the middle of the wing; the anal veins are not preserved.

The species is a large one, the fragment being 22 mm. long, while the entire wing can hardly have been less than 33 mm. long, and its breadth, which is preserved, is 15 mm., making the breadth to the probable length as 1 : 2.2. The veins are slightly elevated and distinct and regular. There appears to be no reticulation or cross venation whatever, and the surface of the shoulder of the wing is particularly smooth.

The species appears to be most nearly allied to *M. Heeri*, but it is much larger than it, or, indeed, than any other species of the genus, except the preceding, and its anal furrow is even more longitudinal and less arcuate than in *M. Heeri;* it differs also from the latter in the much greater number and closer approximation of the mediastinal nervures and in the downward sweep of the externomedian veins, probably causing the area to occupy the margin wholly below the apex of the wing. In the stout square humeral lobe of the wing, in which the veins are obliterated, it seems to be peculiar, as it is also in the regularity of the curve of the anal furrow.

The single specimen upon which the species is based was found by Mr. R. D. Lacoe at Port Griffith Switchback, near Pittston, Penn., and bears the No. 2017 in his collection.

5. **Mylacris pennsylvanicum.**

Pl. 18, fig. 11.

Mylacris pennsylvanicum Scudd., Mem. Bost. Soc. Nat. Hist., III, 44–45, pl. 5, figs. 13–14.

A second specimen of this species enables me to supplant the previous description from an imperfect specimen by a better; the present specimen is also imperfect but makes up in part what the other lacks.

Fore-wing. The distal extremity is lost in each, but more of the costal is preserved in the new specimen, while the inner margin is almost completely lost in both; the form of the wing can nevertheless be judged with probable accuracy; the course of the veins indicates a shorter and stouter, as it certainly is a broader wing than in *M. Heeri*. The

humeral lobe is prominent, its straight basal side bent at nearly a right angle with the arcuate costal edge, the angle rounded off; the costal margin is considerably arcuate, more strongly at extreme base and beyond the middle than in the intermediate straighter portion where the arcuation is very gentle; in this respect the figure previously given is slightly inaccurate. The course of this margin with the breadth of the wing and the direction of the veins render it probable that the rest of the wing had the form given in the dotted lines in the figure, in which the apex of the wing falls within the middle line, and slightly changes the form from what was given before, and which we had already noticed as probably not correct. The veins originate from the middle of the wing and curve a little at the base. The mediastinal area has a basal width of very nearly half the wing, and, separated from the scapular by a scarcely curved line, strikes the costal margin at about the end of the second third of the wing (in one specimen probably a little less than that, in the other probably a little more); the basal part of the costal margin is very narrowly and delicately marginate; the part of the mediastinal area next the humeral angle is not veined, but below it are four or five scarcely curving, long, gently diverging, simple or deeply forked veins; the middle ones simple (possibly united nearer the base, where they are not sufficiently preserved to see it), the others forked. The scapular vein is gently and broadly sinuous and probably terminates just above the apex of the wing; in the basal part of its course it runs closely parallel to the costal margin and a little nearer to it than to the inner margin; in the latter half or more it curves in an opposite sense to the costal margin; it commences to branch very near the base, and emits four or five branches, simple or forked, rarely compound, long and nearly straight, having the same direction as the outer mediastinal veins; in one specimen the basal, in the other the apical vein is compound, the rest generally simple. The externomedian vein is somewhat arcuate until it divides, a little beyond the basal third of the wing; both these branches again divide scarcely beyond the middle of the wing, the uppermost again forking not long after; probably they fork more, and, as in the central part of the wings, fill their area with dichotomizing veins whose general direction is nearly longitudinal, with a slight downward tendency, but closely approximated, so that on the edge the veins occupy a narrow area mostly below the apex of the wing. The internomedian runs in a broadly sinuous course parallel to the preceding vein, probably strikes the lower margin where the wing begins rapidly to narrow, and emits four or five, perhaps more, simple or basally forked, indistinct, arcuate branches, which occupy upon the inner margin about as much space as the scapular upon the costal margin. The anal furrow is strongly impressed upon its basal half or more, less so but still distinctly beyond, is composed of a pair of closely approximated fine grooves, and is regularly and not very strongly arcuate, terminating on the inner border at some distance before the end of the mediastinal area, at just about the middle of the border; the anal veins are numerous and closely crowded, nearly all simple, and all slightly arcuate.

It is a tolerably large species, the breadth of the wing being 13.5 mm. and its length probably 26 mm.; or, its breadth to its length about as 1 : 2; the actual length of one fragment is 19 mm., of the other 20.75 mm.; the condition of the first is mentioned in the former description of the species; the second specimen is represented both by that drawn and by its reverse; in the one drawn the veins are in relief and the figure represents, therefore,

the under surface of a right wing (or a cast of the opposite) in which, as in the individual previously described, slight indications of transverse wrinklings may be seen here and there and especially in the scapular area, but there could have been no regular or definite reticulation.

The species differ from *M. Heeri*, its nearest ally, in the stronger curvature of the anal furrow, and in the greater width of the anal area but not in its greater abbreviation, as previously stated, the breadth of the area making up for the greater curvature of the furrow; it also differs, as before stated, in the sinuosity of the scapular vein, the more arcuate line of separation between the mediastinal and scapular areas, and the more crowded branches of all the areas but the internomedian; the wing as a whole is also proportionally broader.

The new specimen comes from the same bed as the last, and was sent me by Mr. R. D. Lacoe of Pittston, in whose collection it bears the number 2024. It occurs on the same stone as *M. carbonum*.

6. **Mylacris carbonum** nov. sp.

Pl. 13, figs. 6, 7, 10.

Fore-wing. The greater part of the wing is preserved, but the apical fourth or fifth of the tip is missing as well as a patch along the inner margin from the tip to the anal area. From what remains, the wing had probably a form somewhat like that of *M. anthracophilum*, but was not quite so tapering, the costal margin being a little less convex; the inner margin next the anal area was straight. The veins originate from the middle of the wing, but do not curve at the base. The mediastinal area has, therefore, a basal width of half the wing and extends to beyond the anal, or probably to just about the middle of the wing; in the humeral portion of the area no veins can be made out, but in the opposite half two compound veins can be seen, the first consisting of a pair of simple veins united basally, the second of a pair of forked veins united basally very near the extreme base of the wing; both of these veins are forked about midway in their course, the outer twice, close together. The scapular vein can only be traced basally to where it begins to curve inward, a little beyond the forked mediastinal vein just described; it, together with the next vein in close juxtaposition, curves strongly but only for a very short distance, and the curve of the anal furrow would seem to preclude any further continuation of the curve, so that in reaching the base of the wing it must resume its outer course; beyond this basal curve it is straight and must strike at the apex of the wing, though it cannot be traced throughout; in the fragment it has five equidistant branches, and probably has a couple more before the tip; the third of these is forked not far from the base, but all the others, so far as seen (excepting the first) are simple and straight, although very long, for the straight main vein runs sub-parallel to the costal margin scarcely above the middle line of the wing; the first branch, however, differs from the rest; it originates where the main vein begins its straight course, and continues the direction of the deflected basal part of the vein, and emits from its apical side three long, straight, equidistant offshoots, the first from its very base, the last half way to the margin. The externomedian runs in a straight line scarcely below the middle of the wing and first divides a little before the middle, and in

the fragment has three simple slightly curved branches, their convexities toward the anal area, and their bases considerably further apart than the scapular branches. The internomedian runs parallel and close to the externomedian vein and its basal branch, probably reaching the inner margin more than half-way from the anal furrow to the apex; it commences to divide as soon as there is space for it opposite the middle of the anal furrow, the first branch forking, and the second branch originating, next the first branch of the externomedian vein; a third branch springs at a similar distance further on, but more cannot be seen. The anal furrow is tolerably distinct, curved gently throughout and bent a little in the middle, terminating at more than one-third of the distance toward the tip, or about opposite the first divarication of the externomedian vein; the anal veins are exceedingly numerous and crowded, many of them forked, some of them doubly, generally near the middle of their course; those next the anal area are obliterated, but if they retained the character of the remaining part of the area, about twenty veinlets must have impinged upon the outer margin in the anal area; those lying next the angle of the wing have a sinuous course, changing to a simple gently arcuate curve toward the anal furrow.

This fragment represents a species of tolerably large size, the breadth of the wing being 13.5 mm., the length of the fragment 23 mm., and the preserved length of the wing about 27 mm.; so that the breadth to the length must have been as 1 : 2. It is the under surface of a right wing, all the veins and the anal furrow being in relief and, with the exception of the anal veins and the internomedian branches, somewhat prominent. No trace of reticulation or transverse wrinkling can be seen.

The specimen occurs on a piece of black carbonaceous shale with reeds at Cannelton, Penn., and was sent me by Mr. R. D. Lacoe with the number 2022 a.

After the above description was prepared two other specimens came into my hands through the indefatigable exertions of the same friend. As they are less perfect than that already described, the points in which they vary from it may best be pointed out by separate description.

The first, No. 2022 b, c, occurs in duplicate on the same stones with No. 2024, *M. pennsylvanicum*, and was found at Cannelton, Penn., in the same shales as that which yielded the type. It preserves a middle fragment of the wing, with a portion of the costal margin only, and a minute bit of the inner margin; no part of the wing appears which is not seen in the type, unless it be a little more of the externomedian vein. It is a little smaller than that specimen, its width at the end of the basal third of the wing being 11 mm., where in the other specimen it is fully 13 mm. In 2022 b, c, all the mediastinal veins are straight and simple as far as they can be seen, so that they do not divide beyond the base, giving this area a very different appearance from what it has in 2022 a. The scapular vein, although extending on the fragment as far toward the apex as in 2022 a, has only three branches, the outer two simple so far as they can be seen, the basal, however, dividing at its very base into two forked branches, the upper fork of the upper branch again dividing; this is somewhat different in description from the condition in 2022 a, but is really much the same as if the second offshoot of the first branch were united to the first offshoot and they together arose in the axilla of the first branch. The externomedian vein also differs somewhat and reminds one rather of the arrangement of that vein

in *M. pennsylvanicum*. It commences to divide at the same point, but instead of two or three simple inferior branches with a tolerably good expansion it forks narrowly in a longitudinal fashion, and each of its forks simultaneously divide in a similar way a little further on. Below this the wing is not well preserved, but the veins that do show do not appear to differ from the type.

The second additional specimen, No. 2022 d, comes from a different locality, the Empire Mine at Wilkesbarre, Penn., and was found at the horizon of the E. vein on a piece of gray shale filled with remains of ferns, etc. This specimen, excepting in the internomedian area, preserves also no part not found in 2022 a; it is of the same size as it, measuring fully 13 mm. in width at the same point; the basal half of the costal border (excepting the humeral angle) and a fragment of the inner margin beyond the anal furrow are preserved; the costal margin is represented as perhaps too convex in the figure, where it should correspond very closely to 2022 a. The veins of the mediastinal area are better preserved than there and resemble their disposition more closely than that of No. 2022 b, c, being compound or two-forked away from the base, while in 2022 b, c, they are all simple; they diverge from one another more widely than in 2022 a, and those toward the humeral angle are simple, distant and incomplete. The scapular vein agrees very closely with its disposition in 2022 b, c, differing only in having an additional branch in the same space, in which it agrees more closely with 2022 a, and in having the axillary branch simply forked instead of compound. The externomedian vein does not agree with either of the other specimens; its main stem runs closely parallel to the scapular and has only one branch, which is emitted in a similar position to that of the first branch in the others; this branch, however, is compound, its upper fork dividing, and the whole area which it appears to occupy, in the lost part of the wing, as broad as in 2022 a. The internomedian area appears to be exactly as in 2022 a, but as a general thing only the terminations, while in 2022 a only the bases, of the veins can be seen; the fragment of the inner border at their tips is straight. The anal furrow appears to be more gently and regularly curved than in 2022 a, but the difference is slight. No anal veins are preserved.

The differences between these specimens, although considerable, do not seem to be more than individual and strengthen rather than weaken the validity of the other species of the genus, and support the distinctions upon which they have been separated from one another.

This species, peculiar for the excessive crowding of the veins in the anal area, falls in its general features between *M. pennsylvanicum* and *M. anthracophilum*. From the latter it differs in that the veins do not curve downward at the extreme base of the wing, but have a sinuous course, the greatest curve being nearly as far out as the middle of the anal area; in the simplicity of the scapular veinlets and the composite character of the first branch; and in the crowded condition of the anal veins in contrast to the comparative openness of the neuration elsewhere, nearly all the nervules being long and simple, while in *M. anthracophilum* nearly all are forked about the middle. From *M. pennsylvanicum*, which comes from the same general locality, it differs in its more tapering form, due to a greater convexity of the costal margin; in the straighter course of the scapular vein, the more gentle sweep of the anal furrow allowing a much narrower space for median veins, which in *M. pennsylvanicum* first divaricate at the same point, but here, notwithstanding the narrowness

of the space, the internomedian first forks between the first and second branches of the scapular, while in *M. pennsylvanicum* only opposite the base of the third branch; the anal veins are also much more numerous in the present species.

7. Mylacris anthracophilum.

Mylacris anthracophilum Scudd., in Worth., Geol. Surv. Ill., III, 568–570, figs. 5, 6.—Ib., Mem. Bost. Soc. Nat. Hist., III; 45–47, pl. 5, figs. 6–8.

Colchester, Ill.

8. Mylacris priscovolans.

Pl. 13, fig. 9.

Fore-wing. A bit of the extreme tip and a considerable part of the wing next the inner border is wanting, although the position of the margin itself is indicated by a depressed line upon the stone, showing the form of the wing to have closely resembled that of *M. carbonum*, being broadest at the extreme base, narrowing toward the apex with increasing rapidity, so that the inner margin being straight, the costal margin is considerably curved; the tip, though narrow, is broadly rounded, and lies within the median line of the wing; the humeral lobe is very square, rounded only at the extreme angle. The mediastinal area is of a very regularly triangular form, one-third the width of the wing at the base, and apically extending considerably beyond the middle of the distal half of the wing; its three or four veins fork near the base, and extend their long, simple, or branching rays far out to the margin. The scapular vein is rather strongly curved near the base, beyond which it sweeps with a very slight opposite arcuation, subparallel to the costal margin to the very tip of the wing; its four or five long and mostly simply and deeply forked branches have a completely longitudinal course, and the area forms a triangle of about the same size and regularity as the mediastinal area, but with an opposite disposition. The externomedian vein passes with a curve similar to, but stronger than that of, the scapular vein, diverging from it, and terminating on the inner margin beyond the middle of the outer half of the wing; but within the extremity of the mediastinal vein, its long, arcuate, simple, or simply forked branches being superior. The internomedian vein is again curved in the same sense as the externomedian and has about four simple or forked arcuate branches. The anal furrow starting from above the middle of the wing is deeply impressed, regularly and considerably arcuate, but more strongly curved in its basal than its apical half, and terminates at the middle of the inner margin; the anal veins are oblique or arcuate, simply forked or compound, somewhat irregular and hardly more crowded than the internomedian veins.

The species is a large one, the wing measuring 26.5 mm. in length by 14.5 mm. in breadth, the breadth being to the length as 1 : 1.8; the continuous part of the fragment is 25 mm. long and 12 mm. broad at the base. The wing is a right one, the under surface (or cast of the upper) having been figured, and the veins are distinctly and sharply impressed; no sign of cross venation or of any reticulation appears. The wing is peculiar for its excessive breadth at base combined with its square-shaped humeral lobe, which causes it to taper from the very base; it is nearly allied to *M. carbonum* and *M. anthracophilum*, differing from both in the peculiarities just noted, as well as in the less produced and

more fully rounded apex, and the considerably greater extent of the mediastinal area; the veins of the anal area are less crowded and less regular than in *M. carbonum*, and the externomedian branches are superior instead of inferior; hence it agrees better with *M. anthracophilum*, but the externomedian vein lacks the basal branch found there and the anal veins are not so regularly disposed; the much less strongly curved costal margin is dependent upon the basal breadth of the wing, already mentioned.

The specimen figured is numbered 2031 a, in Mr. Lacoe's cabinet, and its reverse No. 2031 b. It comes from Cannelton, Penn.

9. **Mylacris Mansfieldii.**

Mylacris Mansfieldii Scudd., Mem. Bost. Soc. Nat. Hist., III, 47, pl. 5, fig. 15. Cannelton, Penn.

10. **Mylacris ovale** nov. sp.

Pl. 13, fig. 5.

Fore-wing. The anal area and the extreme base of the wing is absent, but the larger part of the wing is entire with perfect margins except an unessential fragment, showing the wing to have been a little more than twice as long as broad, very regularly oval, with similar and symmetrical costal and inner margins and a rounded subacuminate tip. It is peculiar for the basal narrowness of the mediastino-scapular area. The mediastinal area is very small though reaching beyond the middle of the wing, for next the base it is not more than one-fifth the width of the wing and begins to narrow opposite the end of the anal furrow; its veins are only two or three in number, simple or forked, very gently arcuate and subparallel, the limitation between the mediastinal and scapular areas being arcuate in a sense opposed to that of the anal furrow. The scapular vein has a considerably arcuate course throughout; starting so as to be fairly within the upper fourth of the wing, it curves first downward and then upward with a regular sweep which includes two-fifths of the wing in the middle, and terminates just above the apex of the wing; it emits in this specimen four branches, gently arcuate in the same sense, simple, singly or doubly forked, all but one of which are thrown off in the basal third of the wing, not very far apart. The externomedian vein has an arcuate course in the same sense as the preceding, running in the outer half of the wing subparallel to the inner margin; it commences to divide before the end of the anal area and emits four inferior equidistant branches, the last opposite the end of the mediastinal area, the extreme ones simple, the middle ones simply or doubly forked, all considerably curved in the same sense as the main vein, at least at their base. The internomedian vein curves again in the same sense, taking no curve toward the inner margin until close to the tip, and reaching the margin farther from the apex of the wing than the scapular vein, so that the larger part of the externomedian area is below the apex; it emits half a dozen or more very long, simple, or simply forked veins, all arcuate in the same sense, though more gently; three of them arising near the base far within the tip of the anal furrow, three other near the middle of the wing at no very great distance apart, and probably an apical one. The anal furrow is lightly impressed, very slightly arcuate and probably terminates before the end of the basal third of the wing. No anal veins are preserved.

The species is a large one, the fragment measuring 24.5 mm. long and 12 mm. broad; probably the entire length was not less than 28 mm., and the breadth to the length as 1 : 2.3. The wing is a right one, of which the under surface is shown in the figure and the upper in its less complete counterpart. The veins are distinctly marked, and somewhat prominent on the under surface, excepting those of the internomedian area and all the veins in the apical fourth of the wing; no cross veins or reticulation can be discovered.

This species agrees with *M. Mansfieldii* in its form and size and in the inferior origin of the externomedian branches, but it differs decidedly from it, as well as from all other species of the genus, in the sweep of the mediastinal and scapular veins, as well as in the exceedingly restricted area they cover in the basal part of the wing.

The specimen comes from Cannelton, Penn., and was kindly communicated by Mr. R. D. Lacoe, in whose collection it bears the No. 2033.

Explanation of Plate xiii.

[All the specimens are from the collection of Mr. R. D. Lacoe.]

Fig. 5. *Mylacris ovale.* ♀. No. 2033. Drawn with camera lucida by S. H. Scudder.
Fig. 6. *Mylacris carbonum.* ♀. No. 2022 *b*, from Cannelton. Drawn by J. S. Kingsley.
Fig. 7. *The same.* ♀. No. 2022 *d*, from Wilkesbarre. Drawn by the same.
Fig. 8. *Mylacris lucifugum.* ♀. No. 2017. Drawn by the same.
Fig. 9. *Mylacris priscovolans.* ♀. No. 2031. Drawn by the same.
Fig. 10. *Mylacris carbonum.* ♀. No. 2022 *a*, from Cannelton. Drawn by the same.
Fig. 11. *Mylacris pennsylvanicum.* ♀. No. 2024. Drawn by the same.

The other figures belong to the preceding memoir.

The Earliest Winged Insects of America: A Re-examination of the Devonian Insects of New Brunswick, in the Light of Criticisms and of New Studies of other Paleozoic Types.

BELIEVING that science is little advanced by the acrimony engendered by controversial essays, the writer has always avoided replying to any criticisms of his scientific work, however destructive they might appear at first sight, until in the natural course of subsequent studies it became necessary to subject them to public examination. Generally much time will then have elapsed, both parties may view the matter more dispassionately and, notwithstanding the delay, the truth is likely to be sooner reached.

It is on this account that up to the present time I have in no way noticed the objections which Dr. Hagen[1] made four years since to my interpretation of the wing-structure of the Devonian insects,[2] although his criticisms were not always couched in the most temperate language. Now, however, that it has become necessary, for a work in hand, for me to review systematically the entire series of paleozoic insects, the Devonian wings have been studied anew, with the intention of profiting by the comments of so thorough and learned a student of Neuroptera, both recent and fossil, as Dr. Hagen is everywhere well known to be; of profiting also by the greatly extended special knowledge I have myself gained in the last five years through the kindness of many correspondents (and especially of Mr. R. D. Lacoe), who have liberally furnished me with a very considerable number of new paleozoic insect types, discovered in this country.

Without wishing to discredit in the least the worth of Dr. Hagen's general opinion in questions which affect the Neuroptera, I think it is only fair to point out dispassionately to the inquirer of the future four things. 1°. That in the historic development of the broader groups of insects, so far as we now are acquainted with them, no important changes have transpired *since* paleozoic times; while our perplexity regarding the proper relation of paleozoic insects to modern types is often very great, and our conclusions variable. 2°. That Dr. Hagen has published nothing upon paleozoic insects (apart from the paper above referred to upon Devonian insects) excepting scattered notes on a few which he referred to Termitina and which, in all probability, are no Termitina at all.[3] 3°. That there is no evidence, but the contrary, that Dr. Hagen in his investigations, *uses* the "theory of descent" as a working hypothesis, without which no one who is studying any group of animals in the period of its rise and most rapid evolution can expect to do otherwise than stumble and wander astray. To refuse to use it is to merit failure. 4°. That

[1] Bull. Mus. Comp. Zool., VIII, no. 14.

[2] Anniv. Mem. Bost. Soc. Nat. Hist., 1880.

[3] See Proc. Amer. Acad. Arts Sc., XX, 167–173.

of the Devonian wings, Dr. Hagen has studied in nature only the (in most cases poorer) reverses of the original specimens, while several times before and once since the publication of his criticisms I have carefully studied both sets together.

Gerephemera simplex.

This insect was placed by me in a distinct family group to which I gave the name of Atocina. Comparisons were particularly instituted with one of the other Devonian forms, Platephemera, and with Dictyoneura and its allies of the carboniferous epoch, to the latter of which it was thought to have most resemblance. At that time the gigantic forms of Protophasmida made known by Brongniart had not been published, and I was not aware of the variety of neuration found in that ancient type. Now that this is known I am far more inclined, notwithstanding its anomalous structure, to believe that Gerephemera should fall in the same general group, and that the name of Atocina should be dropped; particularly as a new study makes me see that the neuration will bear an interpretation which lessens the points of distinction between them, and renders the structure of Gerephemera less anomalous.

Dr. Hagen, on the other hand, refers it unhesitatingly to the modern Odonata; but a certain part of my description has been plainly misunderstood by him. The costal margin is represented both in the description and in the figure as two to three mm. long; in the figure it is not eight mm. long, as stated by him. I have not said that "the mediastinal vein is never a depressed one in such insects," but "the marginal would then be an elevated and the mediastinal a depressed vein, which [combination] is never the case," etc. He rightly says that no mention is made of the quadrangular cells occurring between the oblique nervules which run from the mediastinal vein to the margin, for they were not looked upon as important and are exceedingly faint and obscure. He remarks that if they exist they would be the only features inconsistent with an Odonate hypothesis, overlooking the fact that the nervules they are supposed to connect are strongly oblique, as never in Odonata and usually in other Neuroptera. The superior origin of the branches of the principal vein preserved, which he calls "probably the sector medius," is also entirely inconsistent with an Odonate hypothesis, and is the most salient point in the wing next to the numerous parallel veins above it, but to this he does not at all refer.

The superior origin of the branches of this vein, however, is not unknown in paleozoic wings as I had supposed, having its counterpart in several of the Protophasmida, as Brongniart calls them, and I am now inclined to believe that this wing should find a place here, somewhere in the neighborhood of Haplophlebium. This would necessitate a different and I think a somewhat more rational view of the neuration, viz., that what I had looked upon as the externomedian is the internomedian vein, and that the externomedian is the first branched vein in the wing, counting from the costal border, the "intercalary nervure" being really a branch of this, room for other branches being found, if the main externomedian branch felt the curvature of the apex of the wing as soon as the other veins; this would bring the slight bend in the outline of the outer border at the extremity of the outermost anal vein (so frequent in insects), but would give an enormous expansion to the anal area, as in the case in some other paleozoic insects and as occurs in several of the Protophasmida, especially in the neighborhood of Haplophlebium.

Dr. Hagen examined the reverse of the principal specimen, and says of it, it "strongly confirms my determination." "It belongs," he says, "to a part of the base of the wing which is not preserved" in the figure published. It shows, according to him, the "sector trigonuli inferior," which belongs to the base of the wing and "is to be found only in Odonata, never in Ephemeridae." Unfortunately for all this, the reverse, now figured for the first time (in reverse) on fig. 9 of the accompanying plate, is the exact counterpart of that portion of the better specimen (of which a figure was published in my former paper), which lies *farthest* from the base of the wing, and a piece of which is poorly figured on our present plate at fig. 8 (again in reverse). As I have had both obverse and reverse to compare both before the larger part of the better specimen was uncovered, again after that addition to our knowledge, and still again for verification since the comments of Dr. Hagen, this point cannot be disputed. It will be observed that in no other place is Dr. Hagen's language more positive than here.

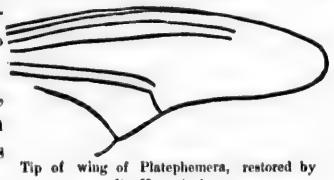
Platephemera antiqua.

This insect was referred by me to the Ephemeridae, because the neuration "agreed in all essential features with that family, and . . . considering the antiquity of the creature shows marvellously little divergence from living types." Its relation to Dictyoneura and allies was discussed, and a "general similarity" of structure pointed out, though they were not considered "closely affiliated."

Dr. Hagen, on the contrary, states that it "has nothing whatsoever to do with the Ephemeridae," adding that his "deliberate determination is not based upon a difference of opinion, but merely on the simple evidence of facts. The specimen is a part of the apical half, without the tip, of a wing of a gigantic dragon fly."

Recognizing the life long labors of Dr. Hagen upon the Odonata, the writer has striven earnestly to see this fossil in the light in which Dr. Hagen declares that he sees it, but is obliged to confess that the distortion is not within his power. The "simple evidence of facts" is unalterably opposed to it, as the following considerations, among others, seem to show, in which the special points of Dr. Hagen's assertions or criticisms are touched upon.

1. In no dragon fly, living or fossil, is there found, beyond the nodus, between the "mediana" and the margin, more than a simple longitudinal vein—the marginal vein; excepting close to the nodus, where the subcosta sometimes appears to extend a very little way beyond the nodus, and then terminates *on the mediana*. In Platephemera there is an additional vein, which, on Dr. Hagen's hypothesis, extends much more than half way from his location of the nodus to the tip of the wing, and terminates *on the marginal vein;* in other words, there is no nodus,—one of the chief characteristics of Odonata, absent, so far as I know, from no dragon fly, living or extinct.



Tip of wing of Platephemera, restored by Dr. Hagen's data.

2. To carry out this hypothesis of an Odonate structure, Dr. Hagen is compelled to say that "something less than 20 mm. of the tip are wanting." To add only 15 mm., as is done by the dotted lines in the accompanying sketch, would, on the most favorable showing, make a wing of ridiculously extravagant appearance; the course of the known portion of the lower margin will not allow us to suppose, at the outside, more than 5 mm., and probably not more than 2 mm. of the tip to be lost.

3. The narrowing of what Dr. Hagen calls the "second cubital space" is a common feature in Ephemeridae (*e.g.* species of Calliarcys, Choroterpes, Blasturus, Atalophlebia, Rhoenanthus, Chloeon, etc.), though not often to quite such an extent, nor perhaps quite so rapidly, as here; and as this varies in different species of the same genus, it seems to be a very unimportant matter: the approach of the two veins, contrary to Dr. Hagen's statement, is mentioned in my paper.

4. What Dr. Hagen calls the sector subnodalis does not run unbroken to the tip, as in all dragon flies I have examined, but is lost in the reticulation shortly before the margin.

In looking over all the ancient types known, I find none to which this insect may be at all closely compared excepting the Ephemeridae; unless it be Breyeria, to which it bears some distant resemblance, and to which it is not impossible that it is allied; but it differs strikingly in every detail from that form, and so much more closely resembles the Ephemeridae of the present day that it would appear to be somewhat of a strain to attempt to bring these two old forms in close proximity, when otherwise the series of forms in the ancient Phasmida is so complete.

I referred in my former memoir (p. 9) to the repetition, in the lower externomedian stem, of the features of the upper stem. If these two are looked upon as distinct externomedian and internomedian stems, we have an additional resemblance in this insect to some of the Protophasmida, though not to Breyeria; yet this repetition, "which appears to have no counterpart among living Ephemeridae," is in reality a feature constantly seen in paleozoic wings, and is indicative merely of simplicity and common origin such as we should naturally look for in early insects; and on this ground we may be justified in considering this insect as a representative of a distinct early type of Ephemerideous insects,—which may be called the Palephemeridae.

Lithentomum Harttii.

This insect I placed in a distinct family of Neuroptera proper; which from "having its nearest affinity to Sialina in modern times," I proposed to call Cronicosialina. Dr. Hagen also recognizes its Sialidan features and compares the wing to that of Chauliodes, adding "the paucity of the offshoots of the scapular branch is by no means exceptional . . . the living Chauliodes possesses only one"

Here again is an evident misapprehension of my language, for while the living Chauliodes has only one scapular branch, it has four or five offshoots of the scapular branch; a "branch" is not a main stem; and the course of the veins, as I have pointed out, forbids our supposing the ancient wing to have had more than one or two offshoots; only one is preserved.

A comparison of this wing with numerous paleozoic wings now convinces me that it should fall with many others in a group in which this branch may have several offshoots; at least it differs from them so little in general structure and in time that this disposition would seem to be the most rational one, and though Dr. Hagen seems to imply (though he does not explicitly state) that the character above mentioned was the only one laying claim to distinguish the Cronicosialina from the modern Sialina, I do not discuss this point here, as I shall soon do so to better advantage, in treating of the whole group.

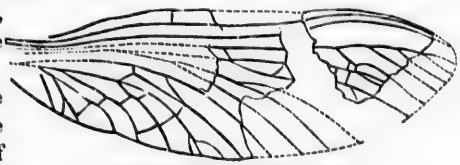
Homothetus fossilis.

On account mainly of a transverse vein near the base of the wing, which I considered homologous with the arculus of modern Odonata, while almost every other feature of the wing was distinctively non-Odonate and generally Sialidan, I looked on this as the type of a distinct synthetic group, which I called Homothetidae, a family "forming the connecting link between the Neuroptera proper and Pseudoneuroptera."

Dr. Hagen, who has not seen the single original, says, "It is obvious that the wing belongs to the Sialina," and explains the so-called arculus as the end of a horny basal part of the wing, such as is seen in Corydalis. "The fragment," he says, "shows nothing foreign to the Corydalis type, excepting a smaller number of transversals."

The re-examination of this form after a special study of a considerable number of later paleozoic wings, some of which agree tolerably closely in general structure with Homothetus, apart from the supposed arculus in the latter, convinces me that I have been mistaken about this arculus. I find, indeed, that, when more closely scrutinized it just fails of reaching the scapular vein above, and that, what I strangely overlooked before, it is elevated, while the other veins about it are depressed; it lies, indeed, at a slightly higher level on the stone than the others, on a piece which shows a fracture farther away from the base of the wing, where the first separation of what I then considered the main scapular branch and the externomedian vein takes place. Upon this elevated piece that portion of the supposed branch lying between the so-called arculus and this separation is placed, and if we discard one we discard also the other; that is, these veins do not amalgamate at their base and curve downward (in passing baseward), but, as a closer examination shows, feebly and uncertainly it is true, both run parallel to each other and are separated by a slight interval, while the supposed obliquely curving basal amalgamation is something foreign to the wing, as, indeed, is shown by its also being elevated and not depressed.

Examined with this new light to seek for the basal attachments of the branching veins, a few faint indications, over that part of the fossil from which the wing has been flaked off (represented in the published drawing by dotted lines), show that there are, between what I formerly called the externomedian vein and the main scapular vein, two separate, parallel, longitudinal veins; moreover, that what I had looked upon as the basal part of the so-called externomedian vein is really only the edge of a flake of stone, beneath which, at a slightly lower point, this vein passes, the vein being unseen further toward the base than where the cross-vein strikes it.



Homothetus fossilis. Corrected sketch.

If, then, within the basal fourth of the wing, between the stout scapular vein, and the so-called externomedian vein (which itself lies lower than indicated in the original drawing), there are two parallel, longitudinal veins, it is highly probable that the upper of them is directly connected with the vein which strikes the tip of the wing and carries several subsequidistant, considerably oblique branches; and the lower with the vein or veins carrying the entire set of more longitudinal branches, between the preceding and what was formerly called the externomedian vein, somewhat in the manner I have indicated on

the accompanying sketch correcting that formerly given, in which the lines marked in longer dashes give the conjectural course of the veins where they are not determinable, and the lines marked with shorter dashes the portions where faint indications on the stone render the determination somewhat more probable. This view is based on the complete change between the course of the nervules attached apically to the uppermost branching vein, and those below it, by which they are separated into two sets, intensified no doubt by the accident which has caused them to overlap where they are nearest together, but even in other respects very distinct.

On this basis we must make a very different interpretation of the entire neuration. The scapular vein must be looked upon as a simple unbranched vein; the vein terminating at the tip, with the more oblique branches confined to the apical fourth of the wing, as the externomedian vein; the branches below this, as far as but not including what I formerly considered the externomedian vein, as branches of the internomedian vein; and the remainder of the nervules impinging on the lower margin, and more closely connected than the others by cross-veins, as branches of the anal vein.

Thus interpreted, the wing falls into a group of paleozoic insects which was perhaps the most numerously represented of all the old neuropterous types in carboniferous times, a group which is separated from all others by the complete independence of the mediastinal, and the lack of any inferior branches of the scapular vein,—a group to which the name of Homothetidae, with this complete alteration of the features by which it was at first characterized, may be applied.

As the lack of inferior branches to the scapular vein is an attribute at the present day of nearly all Pseudoneuropterous wings, and as it occurs in no true Neuroptera whatever, or certainly only in very exceptional instances, we find in Homothetus characters borrowed from prominent features of two great divisions of insects.

As stated above, Dr. Hagen suggested that the "arculus" could be explained by supposing it to indicate the point where, in the front wings of Corydalis, the horny basal part is separated from the membranous portion by a softer integument. This explanation would hardly be tenable on account of the distance in this case of the "arculus" from the base of the wing, but the facts given above show that the explanation is unnecessary.

Xenoneura antiquorum.

A re-examination of both fragments of this wing in the light of Dr. Hagen's statements shows my figure to be correct in every point wherein it has been criticized, except in the wholly insignificant matter of omitting to give with sufficient distinctness what Dr. Hagen has compared to the "recurrent vein" of Hemerobidae. On the other hand, Dr. Hagen is incorrect in every statement of fact where his statement controverts mine. He has had the misfortune to publish his statements after an examination of only the more incomplete and less distinct of the two halves of the fossil. He complains that "the whole wing is shown by numerous parallel and very close longitudinal lines to have been placed beneath or above some part of a plant; on account of these lines some parts of the venation are less distinguishable." In the better St. John specimen these lines do not in the slightest degree interfere with the neuration or its determination, but in at least two specific cases these lines on the Boston specimen have led Dr. Hagen into error.

One case is where he starts upon his theory that two partially overlapping wings are present, one of which I had overlooked,—a theory he could not possibly have maintained with the St. John specimen beside him. "Its hind margin," he says, "is a little below the hind margin of the main wing." Only a mere fragment of the hind margin exists in the Boston specimen, and therefore the marking on the stone which he interprets as the hind margin of a second wing is recognizable with little doubt, and a glance at its relations to the other lines proves at once that it is simply one of the "numerous parallel and very close longitudinal" lines which he refers to a plant. An examination of the reverse shows no such mark at all, and the glazed texture of the stone, peculiar to it where any part of the wing is found, does not extend, on either stone, beyond the limits of the wing as I have defined them.

Dr. Hagen would, however, probably base his double wing theory more upon his next point: that the branches of what I have called the externomedian vein (found on the outer detached fragment) are elevated, while the "corresponding sectors of the main wing" (by which I suppose he refers particularly to the scapular and internomedian veins of the parts on the basal piece) "are depressed." That is, that the detached fragment represents one wing, the basal piece another. But in the St. John specimen, and indeed, though less clearly, in the Boston specimen, we have absolute proof of the inaccuracy of this view, since the externomedian vein, whether on basal piece or detached fragment is, *throughout its course*, elevated or depressed, according to whether obverse or reverse is examined; the same is the case in the reverse sense with the internomedian vein, which is elevated, on both pieces, where the externomedian vein is depressed, and *vice versâ*. A little more familiarity with paleozoic wings would have taught Dr. Hagen to expect this very feature.

Dr. Hagen is equally unfortunate with the scratch of a tool on the costal margin of the Boston specimen, which he would look for in vain on the reverse stone. If it had been shown on my former plate (fig. 5) it would have lain 3 mm. to the right of the outermost cross-vein figured; his making the other existing cross-veins "*therefore* very doubtful" is accordingly unwarranted. The upper branch of the mediastinal fork is exactly as I have figured it, and not as Dr. Hagen represents, as the St. John specimen shows more plainly than its Boston reverse. Dr. Hagen's "cilia" near this point are again the longitudinal lines of his plant. There is no sort of reason for claiming the "fork, as it is called by the author," of the scapular vein, as belonging to an overlying wing, since it does not exist.

Dr. Hagen says he is "not able to classify the insect, except that it belongs to the Neuroptera (*sensu strictiori*)," though he adds, "what we see of the venation is more nearly allied to the Chauliodes type than to any other." He further asserts that "the venation has no similarity to Coniopteryx, Raphidia and Ephemera, and bridges in no way the gulf between the Neuroptera and Pseudoneuroptera, as stated by the author." These are bare assertions, unaccompanied by any proof whatever, and it would therefore be waste time to consider them; it will be enough to say with regard to the first, that, if true, the wing cannot belong to the Neuroptera, as he himself claims it does. My own claim, supported by direct evidence which can be examined into, was that it formed a distinct and extinct family of Neuroptera. My later study of a larger series of paleozoic as well as of existing types confirms my first conclusion.

This new review of the Devonian insects alters somewhat the conclusions which we previously reached. Gerephemera is now considered a member of the group Protophasmida, formerly looked upon as its nearest ally, but from which it was regarded as distinct. The structure of Homothetus is shown to be different from what was formerly supposed, in taking from it its presumed Odonate affinities, but its position is otherwise retained, and the relation of the major part of the Devonian insects to later, carboniferous types, is shown to be more intimate than was supposed. This latter conclusion has been reached mainly by a study of forms discovered since the former paper was printed and which are yet unpublished; and it is the only point in which the thirteen several general conclusions formulated in my previous paper require any essential modification. It is even still true that notwithstanding the discovery of greater unity between the Devonian and carboniferous insects, the little fauna of St. John has features which instantly stamp it as distinct from the carboniferous; since, while most of its members belong to restricted groups which occur in carboniferous deposits, they are in most cases very different from the later members of these groups.

Instead, therefore, of the five species[1] being divided;—none to Ephemeridae, two to Odonata, and three to Neuroptera proper (and "probably" to Sialina), as claimed by Dr. Hagen, we find none whatever belonging to Odonata, but of the two so claimed, one referable to an ancient type of Ephemeridae, and one to an ancient type of Phasmida; while the remaining three belong to as many distinct families of ancient Neuroptera, doubtless related to, but still distinct from, Sialina, two of which were well represented in carboniferous times. The third, however, had, so far as yet discovered, no representative even among paleozoic insects, and has special interest from its distinct resemblance to the carboniferous Protophasmida,—a group afterwards differentiated as a special type of another order.

EXPLANATION OF PLATE XIV.

I venture to add to this paper a plate engraved many years ago from imperfect and rude drawings of my own, which was discarded when I published my memoir on the Devonian insects, as insufficient and in part incorrect. It will serve, perhaps, to explain some of the changes my views have undergone, and to further illustrate to a slight degree some of the errors into which my critic has been drawn. All the figures excepting fig. 5 are of the natural size.

Fig. 1. *Homothetus fossilis.*

Figs. 2, 3. *Lithentomum Harttii.* These figures differ from those given in my formerly published plate to a considerable degree.

Fig. 4. *Dyscritus vetustus.*

Figs. 5, 6, 7. *Xenoneura antiquorum.* Fig. 5 is made up from several camera sketches, and is enlarged about 20 diameters.

Figs. 8, 9. *Gerephemera simplex.* These represent both obverse and reverse, as they originally appeared. Fig. 9 is the one that has never been figured before. All or nearly all of these wings appear in reversed position on the plate. Fig. 9 should have been turned a little.

Figs. 10, 11. *Platephemera antiqua.* It will be noticed that fig. 11 shows what looks like a bit of the outer margin not far from the tip; this I suspect is simply a series of cross veins and was meant to represent only that; it is, however, given precisely in this way in my original drawing.

[1] Omitting Dyscritus, too imperfect for any satisfactory discussion.

Palaeodictyoptera: or the Affinities and Classification of Paleozoic Hexapoda.

Excepting the cockroaches, which form so large a proportion of carboniferous insects, most of the known paleozoic hexapods have long been referred to Neuroptera. But the opinion has been gradually gaining ground that (1) the wide divergence of some of them from post-paleozoic as well as from existing forms, and (2) the occasional unexpected proofs of the combination in single individuals of characters now only known to exist separately in insects of distinct ordinal divisions, *i.e.*, the appearance of broadly synthetic or generalized types, required some modification of our earlier notions. The discovery of Eugereon and the discussion of its structural peculiarities by Dohrn, Hagen, Gerstaecker, Snellen van Vollenhoven, Packard, Brauer, Goldenberg, etc., did more than any thing else to suggest and enforce this opinion.

Dohrn himself in his very earliest paper went so far as to propose to place Eugereon in an ordinal group apart under the name of Dictyoptera, and in the following year to add to the same order the group of insects then known under the name of Dictyoneura. Ten years later, in changing this ordinal name to Palaeodictyoptera, on account of previous employment of Dohrn's term, Goldenberg also included in it the types described by Dana as Miamia and Hemeristia, and Beneden's Omalia; Brongniart has of late years employed it in much the same sense, his only really distinctive addition being that of Geinitz's Ephemerites[1].

The recent startling discovery by Brongniart of insects plainly related in no very distant way to modern Phasmida,—a highly specialized and unique group of Orthoptera,—but yet bearing wings whose venation compels us to connect them directly with the synchronous type of Dictyoneura,[2] and which had heretofore been supposed either neuropterous or to belong to an archaic type some of whose members showed distinct hemipterous characteristics;—

[1] In his latest writings Brongniart, influenced no doubt by the striking combination of neuropterous and orthopterous characters which he discovered in Protophasma and Titanophasma, has endeavored to supplant this term by Névrorthoptères. Three distinct objections can be made to this: 1. The group already has a good name which has been previously accepted by Brongniart, and which the recognized laws of nomenclature will not allow us to set aside; 2, as a distinctive term his fails to cover the synthetic characters of the entire group (cf. Eugereon); 3, the accepted language of nomenclature is Latin and not French.

[2] See Proc. Amer. Acad., xx, 167-173.

this discovery following close upon my demonstration that all paleozoic cockroaches belonged to a type distinct from and taxonomically equivalent to existing Blattariae, lends countenance to a new attempt to discuss the relationship of all paleozoic hexapods to each other and to later types. The time has plainly come for a revision of our general knowledge in the light of special discoveries.

Our acquaintance with paleozoic hexapods is mainly based upon the structure of the wings, and this is greatly simplified by the fact that, as has been previously noted, differentiation in the structure of the front and hind wings of insects had not in paleozoic times obscured the neural framework of the front wings. It is nevertheless true that the great advances in our knowledge of relationships among paleozoic insects have *not* come from a study of the wings, but from the happy and rare discoveries of other parts of the bodily structure, as in Eugereon and Protophasma. This would be supposed to render any attempt to reduce the entire series to systematic order somewhat hazardous, were it not that, as will appear later, the great body of forms now known can be grouped, by their wing structure, into a few distinct types, whose relation *inter se* is such as to warrant a belief that they must have been structurally related in the rest of their organization; and that, among the forms so related, one or another has generally preserved such fragments of the body as enable one to speak with some degree of confidence; at the same time it will have to be admitted that while we are dealing with imperfect remains, any deductions which may be drawn from inferred structure is valuable only as it is cumulative.

Brongniart in his latest papers, while, as stated above in a note, unnecessarily and undesirably dropping the name Palaeodictyoptera,—a name historically connected with the greatest advances in our knowledge of the relationship of paleozoic insects,—has also extended its scope, so as to include also all the forms he (and others) had previously placed under Neuroptera and Orthoptera, but, impliedly, leaving the species of Fulgorina still under Hemiptera. There is no reason for this exclusion, and it is probable that it was not intended.

Leaving aside, for a moment, the question of the existence of paleozoic Coleoptera, we submit that the same reasons which would justify the use of the term Palaeodictyoptera for Eugereon alone, as was done in the first instance by Dohrn (for its predecessor Dictyoptera), compel us to include in it the entire series of paleozoic hexapods. It is a name too which is peculiarly appropriate to the insects of the paleozoic epoch as a whole, with their undifferentiated wings. It is as applicable to the ancient ephemerids as to the phasmids or cockroaches, and any definition of it grounded on known characteristics must be based almost wholly upon the structure of the wings, from which the name is derived; this structure is, collectively, so simple, the similarity between representatives of groups whose descendants are afterwards ordinally distinct so striking, that we may be justified in claiming the probability of the homogeneity of other parts of their structure. At all events the known facts of the structure of paleozoic insects, apart from the historic development of the hexapod type in subsequent epochs, would warrant no ordinal separation between them. In saying this I do not overlook the fact that Eugereon was probably a sucking, and Protophasma a biting, insect, for a physiological distinction is of itself of no value whatsoever; it is the underlying structure only that should be considered; and we

have no fact beyond the *subsequent* development of biting types into groups ordinally distinct from sucking types (a fact paralleled in wing structure), to show that from the structure of the mouth parts Eugereon should be ordinally separated from Protophasma.

Whether the paleozoic relics which have been referred to Coleoptera should also be grouped with the Palaeodictyoptera is another question. That coleopteriform insects then existed is I think probable, both from the traces which are reasonably referred to borings similar to those made by existing types, and by the present structural relationship of Coleoptera to types whose predecessors are most plainly recognized among paleozoic forms, *i.e.* other Heterometabola. Troxites—the single relic from the paleozoic referred to Coleoptera—is an obscure object, and may, as Brongniart has suggested, be the fruit of a plant. It seems to me most probable, all things considered, that Coleoptera sprang from such Palaeodictyoptera as were wood-borers throughout life, and which in paleozoic times had no greater differentiation of structure between the front and hind wings than exist in other Palaeodictyoptera. Such differentiation would be likely to arise from the preservation of favored races with such a habit; while the inherent probability that *all* the heterometabolous types had their already diverging stems in paleozoic times, coupled with the entire absence from these rocks of any shards of beetles, which in later rocks are the most readily and frequently preserved of all insect remains, renders the supposition the more acceptable.

If then, Troxites be a fruit, and the above hypothesis account for what are apparently beetle borings in the older deposits, we have left one insect only, Phthanocoris, claimed to come from paleozoic rocks, which shows any considerable sign of such differentiation in structure as led to the existing distinction between the front and hind wings of heterometabolous types, as we now know them.

Another reason for the claim here urged, viz., that all paleozoic insects should be grouped in one order, Palaeodictyoptera, is to be found in the fact that whenever any of the special groups which it includes, whose distinct affinities to special modern types are easily recognized, are compared with these types, they are found to possess characters which distinguish them as a whole from them. My meaning here will be clear by reference to my paper on paleozoic cockroaches; these insects, though plainly cockroaches or the ancestors of existing cockroaches, are nevertheless structurally distinct from the latter to such a degree that it was necessary to recognize them as a separate group, Palaeoblattariae, taxonomically equivalent to the entire modern group Blattariae. The passage from one group to the other took place in early mesozoic times.

The above view of Palaeodictyoptera then reduces itself to simply this: that hexapodous insects were not ordinally differentiated until post-paleozoic time. The example we have given above, however, sufficiently indicates the next step we must take, and that is to distinguish between groups which the historic development of insects shows were the precursors of types ordinally distinct. This it is difficult to do on any other basis than that of *family-continuity*. It is comparatively easy to see that the Palaeoblattariae were the probable ancestors of Blattariae, Protophasmida the precursors of Phasmida, Palephemeridae of Ephemeridae, and Hemeristina perhaps of Sialina; but from wing structure alone, Palaeoblattariae (ancient Orthoptera) are as nearly allied to Palaeopterina (ancient Neuroptera) as they are to Protophasmida (other ancient Orthoptera). Our clew is through the

minor groups, and by their aid, and almost entirely by their aid, we may distinguish between orthopteroid, neuropteroid, and hemipteroid Palaeodictyoptera.

PALAEODICTYOPTERA.

Body more or less elongate, composed of three well-defined regions, head, thorax, and abdomen; mouth parts as in modern Hexapoda, variously developed; antennae filiform, simple; eyes compound. Thorax three-jointed, subequally developed, each joint bearing a pair of moderately long legs; the meso- and metathoracic wings closely similar, equally membranous, supported by a framework in which six principal stems are developed, the first of which always forms the costal margin; the mediastinal is simple or only provided with superior branches, the scapular and internomedian simple or compound, the externomedian and anal nearly always compound, their branches almost always inferior; generally most branches dichotomize; the membrane is usually more or less reticulate with generally irregular polygonal cells; stout and well-defined cross veins are rare; the costal area is generally scant, the anal area generally ample, often very ample, yet not so much from depth as from distal extension; when at rest the wings appear in all cases to have covered the abdomen as in modern cockroaches, white ants and Sialina; but although there is some indication from their greater breadth that the hind wings were then folded, they were never plaited like a fan as in modern Orthoptera. The abdomen was usually long and slender, composed of nine or ten joints, the last one sometimes furnished with a pair of articulated appendages.

[Orthopteroid Palaeodictyoptera.]

Palaeoblattariae Scudder.

The points in which the ancient cockroaches differed from existing types has been fully pointed out in a comparatively recent paper,[1] and need not be repeated here. The classification there proposed has been generally accepted and no little addition to our knowledge of ancient types of cockroaches has since been added. A number of undescribed forms are in my hands from American deposits, including several new genera, and will be made the subject of special papers. Recent explorations in Triassic beds of Colorado have thrown new light[2] on the passage of the Palaeoblattariae to later types and it is announced by Brongniart that he has discovered a cockroach in the middle Silurian. The figures he has given, however (La Nature xiii, 116), though unsatisfactory, would lead us to suppose the insect to belong to the neuropteroid Palaeodictyoptera.

Protophasmida Brongniart.

A classification of the members of this group having been recently proposed by me[3], and as I intend to refer to them more fully on another occasion in fully describing and

[1] Mem. Bost. Soc. Nat. Hist., III, 23–134.

[2] Amer. Journ. Sc., (3) XXVIII, 199–203.

[3] Proc. Amer. Acad. Acad. Arts. Sc., XX, 167–173. A careless error which crept into this paper may be corrected here. Dict. elongata Gold. was placed in both Breyeria and Goldenbergia! It was at first supposed to belong to Breyeria and was accidently left there after it was discovered that its true place was in Goldenbergia.

illustrating the American forms, it will not be necessary to enlarge upon them here. It may be added, however, that the Devonian Gerephemera falls in this group, and that Brongniart is probably correct in assigning Archaeoptilus Scudd. to the vicinity of Dictyoneura.

Archegogryllus priscus. Pl. 15, figs. 2, 3.

Archegogryllus priscus SCUDD., Proc. Bost. Soc. Nat. Hist. XI, 402-403.

In now publishing figures of this fossil, I place it among orthopteroid Palaeoblattariae simply in accordance with my early determination of it, not wishing to speak positively as to the character of so fragmentary and uncertain a specimen. The remains consist of what appears to be a broken leg, and of a fragment of a wing in close contiguity but possibly not at exactly the same level. The wing, as may be seen by the figure, shows only a few parallel veins of varying degrees of stoutness, with one, apparently detached, crossing several at an acute angle; no sign of any margin is seen excepting in the presence above of two or three very distant, delicate, arcuate, oblique veins, apparently of the costal area. The leg is broken into fragments from which an apparent saltatorial femur and a very irregular tibia can be made out, the general course of each straight, but bent at a slight angle with each other. They are somewhat remarkable, for the femur is smooth, has a median flat area bounded by slight ridges, while the tibia is furnished with several prominences of large size; in modern types the prominences when they occur are found only on the femur. There is a slight rounded prominence on the upper surface near the very base of the tibia and another a little beyond the middle; opposite the latter on the upper surface, is a deeply cleft elevation, its hollow corresponding to the elevation on the upper surface; the basal half of the under surface is occupied by a very broad prominence, of nearly equal height throughout, but slightly depressed in the middle and terminating abruptly at either end. The femur is slightly larger than the tibia and more than twice as broad. Length of wing fragment 15 mm., width of same 11.5 mm., length of femur 10 mm., greatest breadth of same 3.1 mm., length of tibia 8.5 mm., breadth of same at base 1.5 mm., at tip 1 mm. More has been uncovered since its first description.

The specimen was obtained by Dr. J. S. Newberry in the lowest cold beds at Tallmadge, Ohio.

[Neuropteroid Palaeodictyoptera.]

PALEPHEMERIDAE Scudder.

This name has just been proposed by me[1] for the ancient Ephemeridae, in which the lower seems to be formed on the same plan as the upper externomedian stem. The ancient types are distinguishable from their fellows, as the modern are from most of theirs, by the great number of cross veins breaking the interspaces into generally quadrangular cells larger then the fine irregular reticulation of other paleozoic insects. The following insects may be referred here:—

Palephemera antiqua SCUDD., Dev. Ins. N. Brunsw. 7, pl. 1, f. 5, 9, 10; Devonian, St. John, New Rrunswick.

[1] Earliest winged ins. Amer., Cambridge, 1885, p. 4.

Ephemerites Rückerti Geinitz, Jahrb. f. Miner., 1865, 385, pl. 2, f. 1; Lower Dyas, Reitsch, Saxony.

Palingenia Feistmantelii Fritsch, Beitr. Pal. Oesterr.-Ung. ii, pl. 1, f. 1-6; Carboniferous, Bohemia.

Although one can hardly doubt the position of this insect, the resemblance of the abdominal appendages to those of Dictyoneura Goldenbergi Brongn., as shown in a sketch kindly sent me by Brongniart, is very striking.

Homothetidae Scudder.

Though one of the characters upon which this group was originally founded has proved to be fallacious, so as to require an entire revision of the neuration of the single insect upon which it was founded, the name may still be applied to the otherwise unnamed group into which I have since discovered that it must fall, as I have proposed in a recent publication.[1]

In this group, which contains a considerable variety of forms, the mediastinal vein terminates on the costa at very varying distances from the tip, being sometimes very brief (Cheliphlebia), at other times very long (Homothetus), almost invariably sending a considerable number of short, oblique, usually simple veins to the margin. The scapular vein, which has no inferior branches, generally runs parallel to, but at no great distance from, the mediastinal, and after passing its limits, which it generally does to a conspicuous degree, continues the emission of branches to the margin now dropped by the mediastinal; this vein seems invariably to terminate just before the tip of the wing. The externomedian vein is generally the principal branched vein, though there is a curious exception in Didymophleps. It generally begins to branch about or a little before the middle of the wing, and then emits from its main stem at regular intervals from three to six oblique nervules, simple or simply forked, and so longitudinal in course that the area rarely infringes far on the inner margin. The internomedian vein is also conspicuously branched, the area generally occupying the larger part of the lower margin, though the anal area not infrequently reaches nearly to the middle of the wing; its mode of branching is very variable; generally it closely resembles the preceding vein, sometimes to such a degree as to make all the offshoots appear as branches of one vein, at other times only beginning to part from the stem after the latter has taken the oblique course of the externomedian branches, and then having a different obliquity. The anal area is generally though not always narrow, but often reaches far out toward the middle of the wing, and the vein is abundantly branched.

This family is readily distinguished from the Palaeopterina, to which it seems most nearly allied, by the course of the mediastinal vein, which terminates on the costa and not on the scapular vein. The externomedian area is also almost always more extensive, and its veins less longitudinal, by which the internomedian area extends to the end of the lower margin of the wing. It would be hard to say to what modern family of Neuroptera it was most nearly allied, as its scapular vein is completely simple, but the general aspect of the neuration leads one to consider it more nearly allied to the neuropterous than the pseudo-neuropterous groups.

[1] Earliest winged ins. Amer., p. 5, 6.

The following are some of the forms falling here, arranged, as far as may be, in their natural sequence.

Acridites priscus.

Acridites priscus ANDREE, Neues Jahrb. Miner., 1864, 163-164, pl. 4, fig. 1.

This species is remarkable for the great length of the mediastinal vein and its uniform distance from the margin, which suggest that it may be a hind wing. Andree referred it to Orthoptera. It comes from the Bohemian coal measures at Stradonitz.

A fragment of a wing, figured here on pl. 15, fig. 9, seems to come in this vicinity. It is remarkable for the excessive length of the mediastinal vein, the longitudinal obliquity of the branches of the same, and the confinement of the branches of the scapular vein to one or two brief nervules at the very tip of the wing. The externomedian branches seem to be almost similarly confined, while the internomedian branches are crowded, nearly straight, and simple or apically forked. It also has the appearance of a hind wing. It comes from the carboniferous beds of Mazon Creek, Ill., and was received from Mr. R. D. Lacoe, in whose collection it bears the number 2055.

Eucaenus (εὐ, καινός) gen. nov.

Stout bodied, the thoracic segments twice as broad as long, the meso- and metathorax very large; the abdomen ovate, the final segments with a median keel; front wings very regular, oblong obovate, the costal border uniformly arcuate, the mediastinal vein straight, terminating before the apical third of the wing, with numerous straight, simple and regular branches; scapular vein terminating midway between the end of the mediastinal vein and the tip of the wing, with similar branches; externomedian vein very important with rather distant branches.

Eucaenus ovalis sp. nov. Pl. 15, fig. 4.

The fore-wings are very regularly rounded, a little more than three times as long as broad, the tip situated rather below the middle, only a little above the termination of the middle externomedian branch; externomedian branches about five in number, taking a course about parallel to the apical third of the costal margin, very distant compared to the mediastinal branches, always forked, sometimes doubly; anal veins more oblique, numerous and parallel. The prothorax has a slight median ridge, and the flat fore femora are minutely, distantly and rather coarsely granulate. Length of body (excepting the missing head) 22 mm., breadth of abdomen 7 mm., length of front wings 22 mm., their probable breadth 7 mm.

A single specimen is known from Mazon Creek and bears, in the collection of Mr. R. D. Lacoe, the number 2049.

Gerapompus (γῆρας, πομπός) gen. nov.

Body slender, elongated, the meso- and metathorax tolerably stout, but the prothorax at

least as long as broad. Front wings obovate, the costal margin slightly less arcuate in the middle than at either extremity, the mediastinal vein subparallel to the costa and terminating near the apical third of the wing, with rather distant simple branches; scapular vein terminating near the tip, with longer and usually forked but otherwise similar branches. Externomedian vein very important with numerous, very long, generally forked, curving branches, subparallel to the outer half of the costal border.

Gerapompus blattinoides sp. nov. Pl. 15, fig. 1.

The general aspect of the closed wings is that of a cockroach. The prothorax is subcordiform, not unlike that of some Carabidae, with a blunt subcentral boss; the parts in front are obscure. The hind leg is rather long, the femur much stouter than the shorter tibia, the tarsi obscure but nearly as long as the tibia. Wings slightly produced at the apex, but well rounded, less than three times as long as broad. Scapular vein first forking some way beyond the middle of the wing, at or beyond the last fork of the mediastinal vein, and then at once curving downward to approach the margin less rapidly. Length of prothorax 3.5 mm., hind tibia 4 mm., breadth of hind femur 1.5 mm., length of front wing 20 mm., breadth of same 7.5 mm.

The carboniferous beds of Mazon Creek; discovered by Mr. F. T. Bliss.

Gerapompus extensus sp. nov. Pl. 15, figs. 5, 8.

The prothorax is quadrate, the mesothorax of the same width in front as the prothorax, but widening posteriorly; the head apparently a little smaller than the prothorax. Fore wings tapering apically but rounded at the tip, less than three times the length of their median width, the costal margin less arcuate than in the preceding species. Scapular vein nearly straight, first branched near the middle of the wing, some distance before the final forking of the mediastinal vein, and unaccompanied by any change in the direction of the stem. Hind wings, very similar to the front wings in size and shape but with the branches of the externomedian vein much more transversely oblique and curving in the opposite sense, their open side being toward the tip of the wing. Length of prothorax 3 mm., breadth of same 3 mm., length of front wings 30 mm., median width of same 11 mm.

Mazon Creek, Mr. R. D. Lacoe, No. 2019.

Anthracothremma (ἄνθραξ, θρίμμα) gen. nov.

Body stout, apparently depressed, the thoracic segments several times broader than long, tapering anteriorly to a subtriangular head and more gradually behind along the almost parallel-sided abdomen, broader at tip than the head. Wings elongated, with nearly straight costal margin, extending far beyond the abdomen; the mediastinal vein extends over about two-thirds of the wing; the scapular vein rather strongly arcuate, and reaching very near to the tip; the externomedian vein closely parallel to the latter, commencing to branch before the middle of the wing and emitting many long, parallel, simple or simply forked, straight or gently curving, longitudinally oblique branches; internomedian branches similar.

Anthracothremma robusta, sp. nov. Pl. 16, fig. 1, 5, 6.

The surface of the body in the specimen illustrated in fig. 6 is not well enough preserved to show much texture, but the head appears to have a median suture and to taper rapidly to a rounded front in advance of the lateral eyes. The prothorax, although very short and transverse, tapers rapidly in front; the mesothorax is a little larger and longer than the metathorax, which does not exceed the abdominal segments in length. The front wings are three and a quarter times longer than broad, with the costa very straight excepting at the extremities; the stiffness of the wing, however, is relieved by the arcuation of the principal veins; the branches of the mediastinal vein are simple, oblique, a little curved, not crowded; those of the scapular vein are few in number, lie wholly beyond the mediastinal and are rather vague; those of the externomedian vein are nearly straight, on one wing about half of them forked at varying distances along the stem, on the other wing in the single specimen at hand most of them simple, and one transferred from the main stem to a forking branch; they are equidistant and not closely crowded. Legs stout and flattened. Length of body 30 mm., of head 3.25 mm., of prothorax 1.5 mm., of entire thorax 6.25 mm., of abdomen 19 mm., breadth of head 4 mm., of thorax 10 mm., of last segment of abdomen 5 mm., length of front wings 28 mm., breadth of same 8.65 mm.

Mazon Creek, Ill. Carboniferous. Collection of Mr. R. D. Lacoe, No. 2048.

Another specimen (figs. 1, 5) is better preserved in some parts, showing the texture of the body to have been uniformly and delicately granulose. The borders of the head are imperfect so that the drawing may here be incorrect. The tip of one of the wings is better preserved so that the form can be better determined. Nothing additional can be gained from the neuration. It comes from the same locality and bears in Mr. Lacoe's collection the number 2052.

Genopteryx (γένος, πτέρυξ) gen. nov.

Wings obovate, with more or less arched costa, and somewhat produced apex; mediastinal vein of variable length, the scapular extending to or nearly to the tip, connected to the veins on either side of it by transverse or oblique cross-veins; externomedian vein very important, commencing to branch considerably before the middle of the wing and by several longitudinally oblique mostly forked veins, closely connected by feebler cross veins, feeding the apex of the wing; internomedian vein also important with several similar veins, the outermost of which runs in close proximity to the basal externomedian branch from its very origin, so that at first sight both externomedian and internomedian branches appear to spring from a common vein.

Genopteryx constricta, sp. nov. Pl. 15, fig. 11.

A single broken wing is preserved with part of another, probably of the same side. It conforms best to the generic characters laid down above in the similar appearance of the externomedian and internomedian branches, which are all less longitudinally disposed than in G. lithanthraca. Another marked distinction from that species is in the comparative narrowness of the area of the wing above the scapular vein, due partly to the less strongly

convex costal margin, and in the much greater length of the mediastinal vein, which in G. lithanthraca scarcely extends beyond the middle third of the wing, while here it does not stop much short of the tip. Probable length of wing 30 mm., its breadth, 8.25 mm.

Carboniferous beds of Mazon Creek (Mr. R. D. Lacoe No. 2046).

Genopteryx lithanthraca.

Gryllacris lithanthraca GOLD., Palaeontogr., IV, 24-27, pl. 4, figs. 1, 2.

Carboniferous deposits of Fischback and Rushütte near Saarbrücken, Germany.

Cheliphlebia (χηλή, φλέβιον) gen. nov.

A large coarse-winged group, with tolerably slender form, indicated by the position of the wings in repose and marks on the stone too vague to be well represented. The wings are elongated with sub-parallel borders, have a scarcely arcuate costal margin and variable tip, and cross veins, unless exceedingly feeble, entirely absent. The mediastinal vein is short, terminating before the middle of the wing. The scapular vein being distant from the margin, though tolerably straight and supplying many oblique branches to the same, reminds one of the species last mentioned. The externomedian veins are few, distant, simple or compound, and terminate mostly on the apical margin; while the internomedian vein extends far towards the extremity of the lower margin parallel to the externomedian branches, and feeds all that margin with transversely oblique, curving branches. This feature, most conspicuous in the first of the species, has suggested the generic name.

Cheliphlebia carbonaria, sp. nov. Pl. 16, fig. 8.

The wing is about three times as long as broad, uniform in breadth over most of its extent, with a very broadly rounded tip. The middle third of the lower margin is almost perfectly straight, giving a stiff appearance to the wing, which seems to be largest beyond the middle; the veins are very pronounced. The mediastinal branches are very different from those of the rest of the wing, being feeble, crowded and arborescent. The internomedian branches, which are distant, are pretty strongly curved, their convexities toward the tip of the wing, and especially curved when, toward the margin, they fork in a claw-like fashion. The anal veins are few in number and more longitudinal than the internomedian branches. Length of wing, probably, 38 mm., breadth 13 mm.

Carboniferous nodules of Mazon Creek, Ill. (Mr. R. D. Lacoe, No. 2034.)

Cheliphlebia elongata, sp. nov. Pl. 15, fig. 7.

The wing is probably about three and a half times longer than broad, broadest in the middle, and beyond that regularly tapering to a prolonged and probably somewhat pointed tip; the veins are obscure. The mediastinal branches seem to be few, distant and simple. The externomedian branches differ considerably on the two front wings, being of the usual type on one side, but more or less arborescent on the other, the subordinate branches forking more than the more important ones. The internomedian branches, which are not distant, are rather gently curved, with their convexities away from the apex of the wing.

Length of fragment of wing 25 mm., probable complete length 28 mm., breadth 7.75 mm. Carboniferous beds of Mazon Creek, Ill. (Mr. L. M. Umbach).

The specimen figured on pl. 16, fig. 7, also belongs to this family, but too little of the neuration is preserved to enable one to speak with any confidence of its exact position. It would seem probable that it should fall here. The insect is exposed on a side view and the wings overlap so as to confuse the neuration at the costal border, but the mediastinal and scapular veins are plainly simple and the former ends on the costa and has few or no branches. The body was elongated and the wings probably about 35 mm. long. It comes from Mazon Creek, Illinois, and bears the number 2018 in the collection of Mr. R. D. Lacoe.

Genentomum (γένος, ἔντομον) gen. nov.

The wings in this group are large and elongated with coarse neuration and abundant, somewhat feeble cross veins. The front is more ovate than the hind wing, the costal margin being more arched, the tip apparently more pointed and the anal area more excised. The mediastinal vein is long, at least two-thirds the length of the wing, and sends abundant though not crowded branches to the costal margin. The scapular vein lies very close to it and emits no branches until beyond it, when it sends off a few more oblique ones and itself extends to the tip. The externomedian vein is separated by an unusual interval from the scapular and emits several stout forked branches, which cover the apical and the extreme outer part of the inferior border. The internomedian vein is forked once or twice only in the front wing, the branches appearing similar to those of the preceding vein; while in the hind wing it bears many shorter and much more oblique inferior branches.

Genentomum validum, sp. nov. Pl. 16, figs. 2, 3.

The only parts preserved in the single specimen known are the greater portions of two wings, a front and a hind wing, widely separated from each other but in the same nodule. In the front wing the greater part of the costal margin, including all of the mediastinal vein and its branches, is destroyed, unless as is probable the first vein shown is the extremity of this vein; in the hind wing the branches of this vein are oblique, increasingly longitudinal away from the base, and often forked and sinuous. In the front wing the externomedian vein is separated from the scapular by a space about equal to the interspaces between its branches before they fork, and is connected with it by distant transverse cross veins, breaking the interspace up into subquadrate cells; in the hind wing, the course of the vein is not so straight, it is rather more widely separated from the scapular vein and, besides the transverse veins, the interspace is traversed by a supplementary, longitudinal, binding vein in the middle of the wing nearly a fourth the length of the latter; the branches of the externomedian vein are more frequently and extensively forked in the front than in the hind wing but do not differ much. The internomedian vein is soon forked in the front wings and both branches again dichotomize to a considerable extent, while in the hind wing half a dozen simple arcuate branches, their concavities toward

the apex of the wing, part from the under side of the single stem. The anal area is broader and the veins more numerous in the hind than in the front wings, but in both they are tolerably simple and take the course of the externomedian branches; near the base they are separated by a broad space from the internomedian branches, a space which is occupied in both wings by a number of longitudinal arcuate wrinkles or independent cross veins, difficult fully to understand. The front wing is broadest about the middle; the hind wing, notwithstanding its basal expansion, in the middle of the outer half.

It may be added that on the same stone (reversed of course on its counterpart) the scapular vein of the front wing is depressed, and the externomedian and internomedian veins with all their branches raised; while in the hind wing, the mediastinal vein, the externomedian vein and its branches, and the branches (only) of the internomedian vein are depressed, while the scapular, the supplementary binding vein and the main internomedian are elevated; showing that on this stone (the one drawn) we see the two wings of one side, one of them upside down. Length of wings 45 mm., breadth 14 mm.

Carboniferous deposits of Mazon Creek. From the collection of Mr. R. D. Lacoe, No. 2047.

Didymophleps (δίδυμος, φλέψ) gen. nov.

This is one of the most anomalous genera of this family, all the veins and branches above the internomedian being longitudinal and nearly parallel to each other and the straight costal margin; the externomedian vein is twice forked not far from the base of the wing, and all the branches run in the same general direction; so does the internomedian vein, which is exceptionally developed, and emits a considerable number of rather distant, parallel, oblique, rarely forked, nearly straight branches.

Didymophleps contusa. Pl. 15, fig. 6.

Termes contusus Scudd., Proc. Bost. Soc. Nat. Hist., xix, 300-301.

The body is crushed past all recognition, and fragments of legs lying between the wings only show that they were slender. The wings, also, are only partially preserved, their bases being destroyed with the crushing of the body and their tips by extending beyond the edge of the nodule in which they are enclosed; more than half of each wing remains, however, comprising some of the more important parts. All the veins from the marginal to the internomedian inclusive, as far as they are traceable on the stone, are nearly straight and parallel; the upper three are also simple, and the scapular area is considerably and uniformly depressed; the externomedian vein is forked near the base of the wing and the space included between the forks, as well as the externomedian area, is traversed by feeble, inequidistant, straight or oblique cross veins. The internomedian vein traverses the middle of the wing, or runs scarcely above it, and emits from its lower border a large number of oblique veins, which run, often with a slightly irregular course, to the margin of the wing; in the fragment there are eight such veins on one wing and six on the other and more imperfect wing, in both cases about equidistant, but more regular and straighter on the left than on the right wing; in both also one of the secondary veins, and one only, arising shortly before the middle of the wing, is forked — on the left side close to its origin, on the right side near the middle of its course. Both borders are perfectly preserved on

the right wing, showing it to be 10 mm. broad; the length of the larger fragment is 20 mm., and the probable length of the wing about 35 mm.

Coal measures of Vermilion Co. Illinois, obtained and sent to me by Mr. Wm. Gurley.

Homothetus Scudder.

The characters of this genus having been misapprehended by me in my detailed paper on the "Devonian Insects of New Brunswick," I have given a revision of them in a recent paper on "The Earliest Winged Insects of America." The genus is remarkable for the length of the mediastinal vein, which is scarcely shorter than the scapular, for the absence of oblique branches of the same, for the absolute simplicity of the scapular vein, and for the small importance of the externomedian vein, which has only a few oblique generally simple branches occupying the apex of the wing.

Homothetus fossilis.

Homothetus fossilis SCUDD., Dev. Ins. New Brunsw., 17, pl. 1, figs. 1-2. Earlier references may be found in the synonomy there given.

Devonian beds of St. John, N. B.

Mixotermes Sterzel.

This genus, considered by Sterzel, not without some reason, as one of the Termitidae, seems to find its place here. Probably the mediastinal vein will be found to reach the margin not far beyond the middle of the wing, where the scapular vein, otherwise simple, first begins to send short branches to the border. The structure of the externomedian vein precisely accords with this family. What Sterzel considers the lower branch of the externomedian is probably the internomedian vein, while at least the lower of the veins considered by him as internomedian should be considered as anal.

Mixotermes lugauensis.

Mixotermes lugauensis STERZEL, Ber. naturw. Gesellsch. Chemn., VII, 273-276, pl., fig. 3-5.

Carboniferous deposits of Lugau, Germany.

Omalia Coem.-Van Ben.

Probably this form belongs here but the original needs a new study, as its curious venation is plainly impossible and no sufficient description has ever been given.

Omalia macroptera.

Omalia macroptera COEM.-VAN BEN., Bull. Acad. roy. Belg., (2), XXIII, iv, 384-401, pl.

Carboniferous deposits of Sars Longchamps, Belgium.

PALAEOPTERINA Scudder.

Wings obovate, several times longer than broad, the mediastinal vein of front pair terminating, usually not far from the middle of the wing, by running into the scapular vein.

The scapular vein throws off an inferior branch before the middle of the wing, generally close to the base, and runs past the extremity of the mediastinal without being affected by it; it usually reaches nearly the tip of the wing, but in some cases does not extend beyond the middle; the inferior branch is forked a few times, the branches, very longitudinal, rarely occupying more than the upper half of the tip of the wing. The externomedian vein is very unimportant, often simple, occasionally divided at the base into two stems, each of which may fork once or twice, and in one abnormal type assuming an importance equal to the main branch of the scapular vein. The internomedian vein nearly always extends so far as to occupy with its branches the whole of the lower margin; the main vein is sometimes strongly sinuous, and the branches are nearly always more oblique than in the Homothetidae, more numerous and arising somewhat continuously from the base outward. The anal vein is provided with many closely crowded, generally longitudinal branches, the area never reaching beyond the middle of the wing.

This account of the structure of the wing differs from that formerly given by me (Mem. Bost. Soc. Nat. Hist., I, 189) in some slight particulars only, due to the discovery of additional types.

The group differs conspicuously from the Homothetidae in the termination of the mediastinal vein, which impinges upon the scapular vein and not upon the margin of the wing. The relative importance of the externomedian and internomedian areas is reversed, and the contrast between the course of the branches in the two areas generally more marked here than in the Homothetidae. The importance of the internomedian area prevents the anal from encroaching beyond the middle of the wing. It differs from the Xenoneuridae principally in the structure of the lower part of the wing, in the complete independence of the externomedian vein, and in the conspicuous branching of the internomedian. The termination of the mediastinal vein separates it from the Hemeristina, as does the less importance of the scapular and externomedian areas. Apart from the termination of the mediastinal vein, the relation of the neuration to existing neuropterous families is much the same as in the Homothetidae. In this respect, however, it more closely resembles the Sialina and Perlina. From these it is separated by the decided deficiency of the scapular branch, whose offshoots rarely fall below the middle of the apex of the wing; by the unimportance also of the externomedian vein, which is usually simple; by the far greater extent and importance of the internomedian area, which may be considered the remarkable part of its structure, reaching out far toward the tip of the wing, and with the anal area occuping nearly half of the wing.

Gerstaecker has in various places claimed that their neuration would place the Palaeopterina in the Perlina, but nowhere specifies the reasons for this belief. The more perfect presentation of the family characteristics, which we are now able to give, shows that his claim is unfounded; indeed, the single point in which a special resemblance can be traced is in the distal union of the mediastinal and scapular veins, by the impinging of the former on the latter in the apical half of the wing; a feature which these two families share in common with the Embidina, Raphidiidae, etc. The externomedian vein, for example, is either simple or divided almost at the base in the Palaeopterina, while in the Perlina it runs undivided past the middle of the wing, separating two great fields, the one above devoid of cross veins, the one below cut, at least in one sex, by numerous prominent cross veins,

and together forming a very distinct and characteristic feature having no sort of counterpart in Palaeopterina.

Most of the genera agree in the structure of the internomedian vein; but in one (Strephocladus) it is remarkable for throwing off its offshoots from its superior, and not inferior, side; while another type (Aethophlebia), which we have placed at the end of the series, is very remarkable throughout, though it would seem to fall in this place.

Miamia Bronsoni Dana.

Miamia Bronsoni Dana, Amer. Journ. Sc., (2), xxxvii, 34-35, fig. (1864).
Mazon Creek, Morris, Grundy Co., Ill.

Propteticus (πρωί, πτητικός) gen. nov.

Body apparently flattened, of moderate size, the thorax very broad but narrowing in front of the wings, the reduction falling on the meso[illegible], the prothorax and head being narrow and prolonged. Abdomen apparently similarly slender. Mouth parts formed of a spreading tuft of organs extended in front of the head and in the same plane. Legs obscure but apparently rather long and slender, and increasing in size in passing backward. Wings large, full, oval, of nearly equal breadth excepting at extremities, at rest considerably overlapping the abdomen; the scapular vein prominently elevated, widely distant from the margin in the basal half of the wing, gradually approaching it in the distal half where the mediastinal vein soon falls into it, and terminating in the margin just before the tip; it has a single inferior branch arising near the base, which divides beyond the middle into two apically forked or simple branches. The externomedian vein divides at base into two long curved branches either simple or apically forked, which, with the branches of the scapular, occupy the whole of the apex of the wing. The internomedian and internal veins occupy nearly half of the wing, the former the outer and probably larger portion, with nearly straight, oblique, rather distant, simple veins. Straight or curved cross veins are scattered over the whole wing.

Like Miamia, this genus has a remarkable aspect from the narrowness of the head and prothorax as compared with the rest of the body. The mesothorax is broader than long and narrows rapidly, so as to be less than half as broad in front as behind, while the head and prothorax, each longer than broad, are parallel sided. Since the mouth-parts project forward in the same plane, the prolongation of the parts in front of the base of the wings is excessive, being considerably more than half as long as the body behind the front base of the wings, and perhaps as great as the extension of the abdomen behind the posterior base of the hind wings. The wings are ample and apparently folded upon the back as in modern Sialina. The hind wings appear to have been of the same general shape or a little broader, but without any special fulness of the anal area; this point, however, is very obscure from the imperfection of the fossil.

The genus differs from Miamia in the even greater slenderness of the head and prothorax, the anterior prolongation and tapering of the mesothorax, the larger anal appendages, and particularly in the neuration of the wings; viz., in the wider marginal field in advance of the scapular veins of the front wings, the arcuate course of the same vein, the much

earlier origin of its inferior branch, and the much wider space between it and the main vein filled with stout, arcuate branches.

Proptoticus infernus, sp. nov. Pl. 17, figs. 3, 4.

Head subquadrate, rounded behind and apparently a little broader than in front, nearly half as long again as broad, very slightly arched above, the eyes and antennae not appearing on the stone; the mouth-parts are nearly as long as the head itself, but do not admit of any clear separation of the parts; apparently, however, they consist of three pairs of very similar, single-jointed, moderately stout blades.

Prothorax similar in shape to the head, but a little larger, subquadrate with rounded angles, and apparently no broader behind than in front, transversely arched like the head, with a slight median carina obliterated in the centre. The head could apparently be partly withdrawn beneath it, since it seems to have been preserved in that condition, as the illustrations show, the front margin of the prothorax appearing to cut the head in halves in fig. 4, where it best appears; while in fig. 3 the hinder edge of the head is seen embraced at the sides by the edges of the prothorax, as is seen better still upon the stone. The front legs apparently are indicated by the scars on either side of the stone, especially by that on the left side of fig. 4 and its reverse, where a tibial joint appears to be marked. The legs are shown by this to have been rather short and very slender; toward the base of the detached scar of the right leg, in fig. 4, is seen the end of a slender femur, which appears even slenderer in the reverse (left side of) fig. 3.

The mesothorax is of a very strange form when taken in connection with the prothorax; it is half as broad again as long, and the wings are attached next the hinder margin, while the parts in front taper, as has been said, to the size of the prothorax, which is considerably less than half the posterior width of the mesothorax; the front margin is roundly excised as if forming a socket for the movement of the prothorax, and the tapering sides are gently convex; the surface does not appear, as in the parts in front, to be regularly arched, but to be furnished with coarse bosses, especially in the medial portions. Its legs are shown only on one side, and that very obscurely, indicating a length about the same as that of the front pair.

The dimensions of the metathorax can only be judged by the size of the legs and wings, the hind wings being ampler than the front pair, and the hind legs longer, so far as can be told from the scars, than either of the others; it can hardly be narrower than the mesothorax, and in all probability was of the same width; its legs, or rather the fracture-scars indicating where they were, are preserved on both sides of the body, and a basal fragment of that of the right side (in fig. 4) is actually preserved, showing again that they were very slender, compressed, and of considerable length, or much longer than either of the other pairs.

The indications of the abdomen are very vague, but show it to have been slender, nearly as broad at tip as the prothorax, and provided with a pair of rather slender, tapering, pointed anal appendages about as long as the mouth-parts.

Front wings broad, more than three times as long as broad, oblong oval, the middle half or more equal or very nearly equal, the apex very regularly rounded; costal margin a lit-

tle shouldered near the base. Marginal vein bordered on the proximal half of the wing by a very narrow and tapering membrane, so that it does not form the actual margin until beyond the middle of the wings. Mediastinal vein parallel to it, impinging on the scapular a little before the end of the middle third of the wing, and running nearer the marginal than the scapular vein. Scapular vein gently arcuate, running in the proximal half of the wing in a straight course parallel to the marginal vein, then bending slightly upward to meet the top of the mediastinal, and in the apical third of the wing curving gradually downward, a little less rapidly than the marginal so as to unite with that not far before the extreme tip (which is broken off); very far toward the base of the wing (near the middle of the basal fourth) the inferior offshoot originates, and runs completely parallel to the marginal vein until it forks, at or just beyond the tip of the mediastinal vein; each of its forks again subdivides in the left wing, at no great distance from the border, the upper one more distant from it than the lower; but in the right wing the upper fork is simple, and the lower as in the opposite wing. The externomedian vein forks near the base, next the origin of the scapular branch, and its branches pass in a broad curve to the tip of the inner margin, the lower one simple, the upper forked apically, the fork being deeper on the right wing than on the left, where, in this feature, it stands midway between the two forks of the scapular branch. The internomedian vein is a little obscure except in the apical portion, where the veins originate a very little earlier on the left wing than on the right; it parts from the neighborhood of the other veins next the forking of the preceding vein, and passes first in a straight line to just about the centre of the wing, when it sends a straight oblique branch to the middle of the apical half of the lower margin; it then takes a course sub-parallel to the costal margin, very soon emits another similar branch, and finally forks opposite the tip of the mediastinal vein; whether it also emits some branches nearer the base is uncertain, but it is probable that either there is a single one thrown off close to the base, parallel to those beyond; or that all the nervules within the first distinct branch belong to the anal vein; these last nervules are obscure, but appear to repeat the course and separation of the internomedian veins.

Hind wings shaped as the fore wings, but more ample, extending at rest, like the fore-wings, beyond the tip of the abdomen, which reaches about the middle of the distal half. Little of the neuration can be made out, but the apical half of the scapular vein appears to be the same as in the front wing. The internomedian vein is strongly curved before it forks in a sense opposed to the general course of the curving veins; it first branches a little before the middle of the wing, and in sending out its three or more branches (a little nearer the base than in the front wing) it turns parallel to the costal margin, and its branches part at a much wider angle and pursue a much more transversely oblique course than in the front wing. The anal area is probably not any fuller than in the front wing, for the hind wing of the right side shows by its apical margin, beneath the front wing of the left side (a margin not shown in the figure), that if there were any fulness to its anal area it should appear beyond the costal margin of the left front wing.

Length of body, from extremity of head (exclusive of mouth parts) to tip of body (exclusive of anal cerci), 34.5 mm., of mouth-parts, 2.5 mm., of head, 3.25 mm., of prothorax, 5 mm., of mesothorax, 5.75 mm., of anal cerci, 2.5 mm., of front wing, 31 mm., breadth of head, 2.25 mm., of prothorax, 3 mm., of mesothorax, 9 mm., of front wing, 10 mm.

This specimen is one of the most beautifully preserved of the fossil insects in nodules which I have seen. It was sent me for study by Dr. Jasper C. Winslow of Danville, Ill., to whom it belongs, and was found by him on Little Vermilion River, about four miles above Georgetown, Vermilion Co., Ill., in a carboniferous deposit. It is referred to as a species of Miamia in the Geology of Illinois, vol. IV, p. 253, where the relation of the deposit to the region is explained. The drawing by Mr. Blake is a very perfect representation of its appearance.

Dieconeura (δις, νεῦρον) gen. nov.

The wings of this genus are long and slender, largest beyond the middle. The mediastinal vein strikes the scapular vein considerably beyond the middle of the wing, while the main branch of the latter, bearing two or more simple or forked branches, which fill the whole apex of the wing, arises in the middle of the basal half of the wing. The externomedian vein is simple. The internomedian vein is very long, reaching nearly to the extremity of the lower margin, and sending at equal distances a number of simple oblique branches to the border. The anal vein with its branches occupies the basal third of the lower margin.

The simple externomedian vein, combined with the importance of the internomedian, are the striking features of this genus.

Dieconeura arcuata sp. nov. Pl. 16, fig. 4.

The scapular branch begins to fork beyond the middle of the wing, and is connected near here by an oblique cross vein to the externomedian vein, which is at first straight and divides equally the broad space in the middle of the wing between the scapular branch and the internomedian vein, but afterwards curves downward following the course of the extremity of the internomedian vein. The latter is strongly sinuous, taking at first a nearly straight course as if it would terminate at about the middle of its actual area, then curving upward into close proximity to the base of the first offshoot of the scapular branch, and then turning to its former course, but arcuate; the main stem is bordered throughout by a dusky band intensifying its otherwise striking character. The abdomen is long and slender, the joints of nearly equal length and breadth. Length of thorax and abdomen 29 mm., of front wing 30 mm., width of same, 7.25 mm.

Carboniferous beds of Mazon Creek, Ill. Mr. R. D. Lacoe, No. 2043.

Dieconeura rigida sp. nov. Pl. 15, fig. 10.

All the veins are remarkably straight and stiff. The mediastinal strikes the scapular vein at an acute angle without bending down to it. The scapular branch has few and distant branches (two only are seen), the first arising far before the middle of the wing and forking near the origin of the second branch below the union of the mediastinal with the scapular vein. The externomedian vein is perfectly straight, filling the equal space between the internomedian vein and the scapular system. The internomedian vein is slightly bent near the middle of the wing and its simply oblique branches are slightly

arcuate. The wing is the only part preserved and is very imperfect, showing only the middle of the wing. The length of the fragment is 11 mm.; probably the whole length of the wing was 20 mm., the breadth 6 mm.

From the intercomglomerate beds of Pittston, Penn. Mr. R. D. Lacoe, No. 2042.

Strephocladus (στρέφω, κλάδος) gen. nov.

The wing is long, slender and nearly equal throughout. The mediastinal vein throws off distant and longitudinally oblique, more or less arcuate or sinuous branches to the margin in the basal half of the wing; in the apical half, in common with the mediastinal, frequent, straight and tranversely oblique branches. The scapular branch arises shortly before the middle of the wing and sends several simple longitudinal branches to the upper half of the apex; it is connected close to the base to the otherwise simple externomedian vein. The internomedian vein is the most remarkable and characteristic; instead of following the course of the externomedian vein and emitting inferior offshoots, it runs to the middle of the lower border of the wing and emits from its superior surface a number of nearly straight simple or forked offshoots parallel to the externomedian vein, to which the uppermost is united by a few basal cross veins. The anal veins are numerous and arcuate.

Strephocladus subtilis.

Petroblattina subtilis KLIVER, Palaeontogr., XXIX, 254, pl. 35, fig. 1.

The peculiarity of the internomedian vein wrongly led Kliver to consider this a cockroach, since Petroblattina presents a similar feature.

Carboniferous deposits of Schiffweiler, Germany.

Aethophlebia (αἰθήρ, φλέψ) gen. nov.

A very remarkable and anomalous genus, particularly in the structure of the internomedian vein, and in the existence of an adventitious vein made up largely of a branch of the internomedian, and running across the externomedian vein into the main branch of the scapular vein in such a way as to appear a baseward continuation of it. The mediastinal vein strikes the scapular a little beyond, and the main scapular branch is thrown off a little before, the middle of the wing; the latter is at first parallel to the costal margin until, just below the tip of the mediastinal, it meets the adventitious vein, when it takes the upward course of the latter until it is in near proximity to the main vein; it emits three or four longitudinal, slightly declivent, parallel branches. The externomedian vein is coalesced with the internomedian at the base, then takes a straight, horizontal course to the adventitious vein, where it forks into two simple branches parallel to the scapular offshoots, the base of the fork forming part of the adventitious vein. The internomedian vein runs in a slightly tortuous course toward the middle of the lower margin of the wing and beyond its middle sends out obliquely upward the main branch which forms the adventitious vein, and from the lower surface of the branch and the outer surface of the main stem arise frequent straight and mostly simple branches like the scapular offshoots.

Asthophlebia singularis sp. nov. Pl. 17, fig. 9.

The single specimen is a nearly perfect wing, broadest in the middle, with the tip lost where it extended beyond the nodule. The straight mediastinal vein is at considerable distance from the nearly straight costal margin and connected with it by straight, transversely oblique, mostly simple veins which become more crowded toward the extremity, and where they arise from the scapular vein, which is sinuous and beyond the tip of the mediastinal approaches the margin. The interspace between these two veins is traversed by straight, transverse veins, but the other main interspaces are crossed by oblique and generally straight but sometimes arcuate and always simple cross veins; the offshoots from the scapular branch and adventitious vein are parallel to each other and equidistant, connected by straight, transverse veins in places (and probably everywhere), making quadrate cells in these narrower interspaces. The large triangular space between the middle portion of the externomedian vein (here straight and parallel to the costal border) and the internomedian and adventitious vein is broken by a sinuous, longitudinal vein parting from the externomedian, below which the cross veins are oblique, above, transverse. The anal veins are obscure, excepting the two outer principal ones which are close together, distant from, and sub-parallel to, the internomedian vein. The lower margin is gently convex. Length of fragment, 31 mm., probable length of the wing, 38 mm., breadth, 12 mm.

Carboniferous deposits of Mazon Creek, R. D. Lacoe, No. 2037.

Xenoneuridae Scudder.

The characteristics of this family have already been given by me in my paper on Devonian Insects.[1] It agrees best with the family just reviewed, in that the mediastinal vein impinges upon the scapular, and that the latter bears a principal branch with offshoots feeding the tip of the wing. But the externomedian vein is peculiar in being amalgamated for a considerable distance with the scapular, and then forking considerably and occupying the outer half of the lower margin; while the inner half is equally divided between the internomedian vein with its basally divided, simple branches, and the anal vein crowded against the border.

Xenoneura antiquorum.

Xenoneura antiquorum Scudd., Dev. Ins. New Brunsw., 24–29, pl. 1, figs. 5–7. Earlier references will be found there.

Devonian beds of St. John, N. B.

Hemeristina Scudder.

Wings elongate, the mediastinal vein simple, terminating on the costal margin beyond, generally far beyond, the middle of the wing. The scapular vein throws off an inferior

[1] Anniv. Mem. Bost. Soc Nat. Hist., 1880.

branch which arises before, generally far before, the middle of the wing, and runs sub-parallel to the main stem; from this branch arise a variable number of obliquely longitudinal, simple, or forked offshoots, which generally occupy the whole of the apex of the wing, and sometimes infringe a little upon the lower margin. The externomedian vein generally extends nearly to the middle of the wing before branching, and then forks more or less abundantly, showing considerable variation in this respect, the nervules sometimes occupying the larger part of the outer half of the inner margin, sometimes reduced to a single branch or two. The internomedian vein resembles the preceding, although it branches from the the base and is generally more important than the externomedian vein where the latter is poorly developed, though sometimes it is simple. The anal veins generally occupy the basal fourth of the inner margin, with a series of simple, or simply forked, sub-parallel branches, generally arising close to the base of the main stem.

This group has been twice described and named by me—once in 1865[1] under the name of Hemeristina, when only a single and rather aberrant form was known to me; and again in 1880[2] under the name of Cronicosialina, when discussing the affinities of one of the Devonian forms. It now appears that not only these, but the series of wings discussed by me in a paper on English paleozoic insects (excepting one, Archaeoptilus, shown to belong in quite another place) should be brought together from possessing one important character in common, characteristic of the neuration of most plannipennians to-day, — the existence of a main scapular branch from which a considerable number of inferior offshoots arise and occupy the entire tip of the wing, or even more than that. In modern plannipennian Neuroptera it is usually more important than here, and the modern groups to which this series of forms bears most resemblance — the series allied to Sialis — differ in that the mediastinal vein impinges on the scapular and not on the costal margin. The ancient group can, indeed, only be looked upon as a generalized plannipennian type, as we have already pointed out in our discussion of the British forms (*loc. cit.*).

Other ancient groups, indeed, the Palaeopterina and Xenoneuridae, agree with it in the possession of a single, main scapular branch from which offshoots arise; but in each of these the offshoots are few in number and importance as compared to what is found in the Hemeristina; from them it further differs in the point of termination of the mediastinal vein, and the usually far greater importance of the scapular branch; while from the Palaeopterina it may also be distinguished by the minor importance of the internomedian vein, and from the Xenoneuridae by the more abundant neuration. Gerstaecker has referred Hemeristina positively to the Ephemeridae, with which it has no more in common than have the other families here characterized, whose mediastinal vein terminates on the costa.

Lithomantis Woodward.

Prothorax with large, dilated, and rounded lateral lobes. Mediastinal vein of front wings running in very close proximity to the border, but farther from it in the middle than at the base of the wing. Internomedian area extensive, occupying the middle third of the lower margin, and fully as important as the externomedian area.

[1] Mem. Bost. Soc. Nat. Hist., I, 190.
[2] Devon. Ins. New Brunsw.
[3] Mem. Bost. Soc. Nat. Hist., III, 213.

Lithomantis carbonaria.

Lithomantis carbonarius WOODW., Quart. Journ. Geol. Soc. Lond., XXXII, 60–64, pl. 9, fig. 1.

Carboniferous deposits of Scotland.

Lithosialis Scudder.

Wings only known. Mediastinal vein of front wings moderately distant from the margin, gradually approaching it all the way from the base; internomedian area unimportant, and far less extensive than the externomedian.

Lithosialis Brongniarti.

Lithosialis Brongniarti SCUDD., Mem. Bost. Soc. Nat. Hist., III, 223.

Carboniferous deposits of Coalbrookdale, England. See the reference above for earlier synonymy.

Lithosialis bohemica.

Lithosialis bohemica SCUDD., Proc. Bost. Soc. Nat. Hist., XXI, 167.

Gryllacris bohemica NOVÁK, Jahrb. geol. Reichs., XXX, 69-74, pl. 2, figs. 1–2.

Coal measures of Stradonitz, Bohemia.

Lithosialis carbonaria.

Acridites carbonarius GERM., Münst., Beitr. zur Petref., V., 92-94, pl. 13, fig. 5;—IB., Verst. Steink. Wettin, 87, pl. 31, fig. 10.

I place this species here from the close general resemblance of the neuration to that of the two preceding species. To do so, however, it is necessary to suppose an error in the figures given by Germar in making the mediastinal vein arise as a superior offshoot of the scapular; but as this correction seems necessary to any understanding of its neuration, it is not a violent supposition. Germar in his later work presumed it to be the hind wing of his Blattina didyma, but it does not at all agree with the neuration of the hind wings of any paleozoic cockroaches.

Carboniferous beds of Wettin, Germany.

Brodia priscotincta.

Brodia priscotincta SCUDD., Mem. Bost. Soc. Nat. Hist. III, 215-217, pl. 17, figs. 3-7. —IB., Geol. mag., (2) VIII, 293-295, 300, fig.

Carboniferous deposits at Tipton, England.

Pachytylopsis DeBorre.

There has been some dispute about the position of this genus, but I think there can be no doubt that its place is here. Through the kindness of Mr. DeBorre I have been able to examine not only the excellent heliotype he has published, but a cast from the fossil, by

which it is evident that while the wing has much the general form and proportions of a modern Pachytylus its neuration is altogether different. The mediastinal vein ends in the margin a little beyond the middle of the wing. The strong and prominent gently arcuate scapular terminates at the upper tip; from it is thrown off before the middle of the basal half of the wing a simple branch parallel to itself, which supports numerous, parallel, oblique branches, the innermost of which strikes the middle of the outer half of the lower border. The externomedian and internomedian offshoots, similar and parallel to those of the scapular branch, are comparatively insignificant and divide about equally between them the space between the scapular and anal veins, which latter strikes the lower margin below the origin of the first offshoot of the scapular branch. An additional proof of its position here is the presence of a long longitudinal cross-vein uniting the base of the main scapular branch with the externomedian branch, as in Brodia.

Pachytylopsis Persenairei. Pl. 17, fig. 7.

Pachytylopsis Persinairei DeBorre, Ann. Soc. Ent. Belg. xviii, 5-6, pl. 5, fig. 1;—Giard, Bull. Sc. Hist. Litt. Nord, vii, 121-122.—VanVolxem, Comptes Rend. Soc. Ent. Belg. (2) xxiv, 20-26.

Carboniferous beds of Mons, Belgium.

Lithentomum Scudder.

This genus differs from all the others placed in this group in the presence of only a single offshoot of the scapular branch; and although this point is uncertain from the imperfect nature of the single fragment, it seems improbable from what is preserved that more can find a place. It agrees, however, in all other features with the family and seems to find its place here.

Lithentomum Harttii.

Lithentomum Harttii Scudd., Dev. Ins. New Br., 22-24, pl. 1, fig. 3, where earlier references are fully given;—Hagen, Bull. Mus. Comp. Zool., viii, 278; Scudd., Earl. Winged Ins. Amer., 4, pl. fig. 2-3.

Devonian beds of St John, New Brunswick.

Chrestotes Scudder.

The termination of the mediastinal vein in the border and not in the scapular shows that this insect cannot be referred to the Palaeopterina as formerly supposed by me. Its place seems to be here in the neighborhood of Hemeristia, though it differs widely from that in the character of the scapular branch, and is peculiar for the deep impression of the principal anal vein.

Chrestotes lapidea. Pl. 17, fig. 2.

Chrestotes lapidea Scudd., Geol. Surv. Ill., iii, 567, fig. 2.

In the figure formerly given the engraver obscured the venation by numerous lines parallel to the veins. The one now given is from a sketch taken by myself at that time.

Carboniferous beds of Mazon Cr., Morris, Illinois.

Hemeristia occidentalis.

Hemeristia occidentalis DANA, Amer. Journ. Sc., (2) XXXVII, 35, fig. 2;—SCUDD., Amer. Journ. Sc., (2) XL, 269-271;—IB., Mem. Bost. Soc. Nat. Hist., I, 191-192, pl. 6, figs. 1, 3;—IB., Geol. Mag., V, 217-218.

Same deposits.

Apparently allied to this, but too imperfect to warrant confidence in a definite statement, is an insect (pl. 17, fig. 8) from the same deposits, received from Mr. R. D. Lacoe under the number 2050. It certainly differs from the preceding in the development and structure and curving disposition of what appear to be the internomedian vein; but the outer half of the wing being lost, no scapular branch can be seen, although one would look for it in the portion preserved. The course of what appear to be the externomedian offshoots—at least as seen on the left side—lead one to suppose that such a branch (or branches) must exist, and the general appearance of the insect is that of this family. The head is transverse, well rounded and strongly convex, and obscure parts in front of it take on a triangular form.

GERARINA fam. nov.

Wings variable in form but usually not so elongate as in the other types, and sometimes remarkably short in proportion to their width. The mediastinal vein is simple, runs close to and terminates in the margin, usually far toward the tip of the wing, and sends numerous oblique offshoots to the margin. The scapular is generally the most important vein in the wing, running parallel to the mediastinal, and emitting several or many longitudinally oblique branches, most of them generally in the outer half of its course; these branches may be perfectly simple, the outermost forked a little, or all more or less forked, and then liable to appear arborescent; even when most numerous they rarely occupy more or much more than the tip of the wing, on account of their longitudinality and their lack of tendency to spread. The externomedian vein is generally less, often far less, important than the scapular, and has two or more branches, the offshoots running parallel to those of the preceding vein, which they resemble so as to be indistinguishable from them when their origin is concealed; the innermost branch never strikes the margin in the basal half of the wing. In one curious type (Megathentomum) this seems to be the most important vein in the wing, and all its branches fall on the broad apical margin. The internomedian vein is generally reduced to a simple vein, or to a lesser imitation of the externomedian vein. The anal area generally extends to or beyond the middle of the lower margin of the wing, and seems usually to be filled with more or less oblique and more or less frequent nervules running to the margin.

This family differs from all the preceeding in that the scapular vein has a considerable number of offshoots depending from the main vein itself and not from a simple principal branch. Nor is there any modern type to which it can be compared. A considerable proportion of the forms are now for the first time described, and all are American, excepting one which is very closely allied to an American form, falling into the same genus, which is in many respects widely different from the other types.

Polyernus (πολὺς, ἔρνος) gen. nov.

Body apparently of moderate stoutness, the wings large and rather broad, well rounded. Mediastinal vein at a tolerable distance from the front margin, to which it sends many curving branches, and extending nearly to the tip of the wing. Scapular vein with three or four distant, inequidistant, but very longitudinal, and therefore closely crowded, ramose branches, the lowermost falling but little below the tip of the wing. Externomedian numerously branched but less ramose, of about equal importance with the preceding. Internomedian with numerous inferior, mostly simple branches, occupying the middle half of the lower margin. Anal veins similar.

Polyernus complanatus, sp. nov. Pl. 18, figs. 8, 11.

The prothorax forms a sort of depressed shield like that of a cockroach, and is tolerably well preserved, showing that it was subquadrangular, narrowing anteriorly, with well rounded front and rounded posterior angles, a little broader than long, the posterior margin convex; the whole surface was rugose, but especially over a large, subcentral but posterior, subcircular boss, the cast of which shows a depression filled with coarse, low granules. The wings are very large and long, evidently extending far beyond the tip of the abdomen, and overlapping, in the single example known, so that it is difficult to separate them, or to distinguish certainly to which wing each belongs. From a careful study, however, it would appear that the mediastinal extends nearly or quite to the tip of the wing (which is lost); that the scapular throws off three long and slightly curving, forked, or multiple forked, offshoots; and the externomedian three or four more oblique, but not more curving, simple, or simply forked, branches. Length of prothorax, 7 mm., breadth of same, 9 mm., breadth of mesothorax, 9.5 mm., length of fragment of wing, 36 mm., probable length of wing, 46 mm., apparent breadth of the same, 12 to 14 mm.

Mazon Creek, Ill. Received from Mr. R. D. Lacoe, No. 2058.

Polyernus laminarum, sp. nov. Pl. 17, fig. 1.

The four overlapping wings are alone preserved, the base lost and the whole somewhat obscure; the tips of all are roundly pointed. The mediastinal vein is much farther removed from the margin in the hind than in the front wing, and shorter; in the front wing it reaches only the rapidly declivent portion of the margin before the tip; the branches both of the scapular and externomedian veins have a strong, but graceful, downward sweep in the apical third of the wing; and the two basal offshoots of the former are forked just on a line (slightly oblique) with the singly forking externomedian branches, and just before the commencement of the downward curve of the nervules; the outer branches of the scapular vein are very ramose, in rather strong contrast to the simple forking of the externomedian branches. Length of fragment 50 mm., breadth of same 30 mm., probable length of wing 65 mm., its probable breadth 23 mm.

A single specimen and its reverse, Nos. 2012, 2013, were received from Mr. R. D. Lacoe. They are from a thin shale interleaved in the conglomerate near Pittston, Penn. (No. XII of Roger's Survey of Penn.), and very near its base, there being but six or eight feet of coarse pebbly rock between this shale and the "red shales" beneath.

Gerarus (γεραρός) gen. nov.

Body slender and elongated, the prothorax rapidly narrowing in front, so that the head is probably narrow and elongated. Wings correspondingly slender, well rounded, but with tips not produced. Mediastinal vein at a considerable distance from the front margin, united to it by many arcuate cross veins, and extending a variable distance toward the tip, but always to some distance beyond the middle. Scapular vein with a considerable number of longitudinal, more or less oblique, simple or forked offshoots, making it by far the most important vein in the wing, the internomedian and anal veins apparently dividing the remaining space about equally between them.

Gerarus vetus, sp. nov. Pl. 17, fig. 6.

The mesothorax appears to be broader than long, the prothorax rounded subtriangular, and in front of it a linear prolongation more than three times as long as broad, which may be the head, or a prolongation of the prothorax; in front of this the stone shows a blackish discoloration. The wings are broadly rounded at the apex. The mediastinal vein extends nearly or quite to the tip; the scapular vein, arcuate and separating itself gradually from the former, again sweeps toward it past the middle of the wing, and throws off a large number of mostly simple, parallel, oblique branches, the earliest of which must strike the lower margin not far from the middle of the hind margin; transverse cross veins are to be seen throughout in the minor interspaces. Length of whole preserved portion 71 mm., of head (?) 11 mm., breadth of same, 3 mm., breadth of mesothorax 10 mm., length of wings 52 mm., breadth across the partly opened wings 23 mm., breadth of wing 19 mm.

Mazon Creek, Ill. Received from Mr. J. W. Pike and now in the collection of Mr. R. D. Lacoe under the number 2054.

A much smaller but very imperfect fossil, figured on pl. 18, fig. 3, appears to belong in this neighborhood, but to be distinct from anything known. Nearly all the numerous nervules of the scapular and lower veins are straight, simply and early forked, parallel and oblique. A future find may enable us to place it more exactly. The length of the fragment is 30 mm., the probable length of the wing about 40 mm., and its probable breadth about 15 mm. It comes from Mazon Creek and bears the number 2016 in the cabinet of Mr. R. D. Lacoe, to whom I am indebted for the opportunity of seeing it.

Gerarus mazonus, sp. nov. Pl. 18, fig. 7.

The body is much elongated, but is very imperfectly preserved, patches only or obscure indications of it appearing at various places. There seems to be a transversely rounded granulated prothorax, in advance of which is a longitudinally ovate head, shaped like that of Eugereon, and in advance of that the base of a tube-like prolongation, which is almost immediately broken at the end of the nodule in which it is embedded, and is half as broad as the head. The abdomen is slender and the wings long and slender with scarcely produced rounded tips. The neuration is imperfectly preserved, and in some parts it is diffi-

cult to determine whether certain veins belong to the upper or under wings, but it would appear as if the mediastinal vein were shorter than usual, not reaching the middle of the outer half of the wing, and that the scapular vein had four or five forking and curving branches, which occupied nearly one half the area of the wing. The neuration would appear to bring the species in this group, and I have accordingly placed it here, but with reserve. Length of body from front of head (excl. appendages) to tip of abdomen 45 mm., of head 3.5 mm., breadth of same 2 mm., apparent breadth of prothorax 6 mm., apparent length of same 4.5 mm., probable length of wing 42 mm., breadth of same 12 mm., width of abdomen 3.5 mm.

Mazon Creek, Ill. Found by Mr. F. T. Bliss and now in my collection.

Perhaps in this vicinity comes another moderately slender species (pl. 18, fig. 5) which is very imperfectly preserved. Very little of the wing structure can be made out, but the general arrangement seems to be much as in Gerarus and to be most nearly allied to what is found in the preceding species. The wings are about 20 mm. long. It comes from Mazon Creek, where it was obtained by Mr. F. T. Bliss.

Gerarus Danae. Pl. 17, fig. 5.

Miamia Danae SCUDD., Geol. Surv. Ill., III, 566, fig. 1.

This species differs from the others placed here by the longitudinal disposition of the veins, which have little obliquity in them. The mediastinal vein extends nearly to the tip; the apical scapular branch is compound, but the others simple; a few cross veins may be seen. It is the smallest species in this genus. The body is very vague but shows enough to prove that it was much elongated. The thorax looks as if it had a median furrow. The wings were apparently about 25 mm. long; their breadth is 8 mm.

Carboniferous deposits of Mazon Creek, Illinois.

Adiphlebia (ἀ-, δίς, φλέβιον) gen. nov.

Body rather stout, of subequal breadth throughout the thorax and basal two-thirds of the abdomen, the latter tapering apically, and the obscure parts in front of the prothorax triangular and about as long as one of the thoracic joints. Wings rather broad, well rounded, with straight costa. All the nervules arising from the main stems in the basal third of the wing and extending without any forking, sub-parallel, scarcely divergent, straight and longitudinal throughout the wing, giving it a very unusual appearance.

Adiphlebia Lacoana, sp. nov. Pl. 18, fig. 6.

The mediastinal vein runs to the declivent portion of the costal margin, the scapular in close proximity to it, throwing off three branches only, close together at the root of the wing, which run parallel to each other unbroken to the tip, where they do not fall below the middle. It is impossible to tell to which veins all the subsequent similarly simple nervules belong, as they also part from one another and their main veins at the very root of the wing. Length of body 31 mm., of abdomen 17 mm., breadth of body 5.25 mm., length of wing 25 mm., its width 9 mm.

Mazon Creek, Ill. R. D. Lacoe, No. 2057.

Megathentomum Scudder.

This genus has certain relations to the preceding, since most of the branches, which are apically formed, must, in most instances, to judge of their direction by the only fragments which are known, have originally parted from the main stem very near the base. The branches are, however, very few in number, and the wing remarkably broad, rounded and large, the main scapular vein branching only near the tip, and the vein there bent upward as if it were a superior branch and the first branch the main vein. Two species are known, one from this country and one from Germany.

Megathentomum pustulatum. Pl. 18, figs. 1, 9, 10.

Megathentomum pustulatum Scudd., Proc. Bost. Soc. Nat. Hist., xi, 401–402; Ib., Geol. Surv. Ill., iii, 570, fig. 7.

The original specimen (fig. 1) is the best that has been found, so far as I know, but several others have been discovered, one of which is figured here. The wing was exceedingly broad, indeed, probably more than half as broad as long. It was broadest beyond the middle and subtriangular in shape, though the outer margin was fully rounded. The mediastinal vein was long, terminating shortly before the declivent termination of the straight costa, and emitting several very oblique and nearly straight branches to it. The scapular vein, parallel to the latter, first branches near the tip of the latter, sending out one or two simple or forked branches which support the upper tip of the wing. The externomedian vein occupies the middle third of the wing, and occupies the largest area, dividing into three branches near the base of the wing, each of which forks singly and rather widely near the border, and at varying distances from it. The internomedian vein divides more than once and supports the lower outer angle of the wing.

In this specimen there are six larger, round or squarish, discolored spots, the surfaces irregularly elevated or blistered; four of them form a bent row in the middle of the outer half of the wing, the upper three spots being nearly straight and the lower one turned inward at a little more than a right angle; the uppermost spot occurs in the scapular-externomedian interspace; the others follow in succeeding interspaces. The two other large spots are found in the same interspace with the upper two of the inner row and are situated about half way between them and the border. There are also many smaller spots, often deeper in tint and not elevated, which appear to be less regularly distributed; they are usually round but sometimes oval or transversely elongated; there are three at equal distances from one another in the lower interspaces formed by the branches of the scapular vein, another occurs just within and above the inner of these three, and one in the angle of the last branch of the scapular vein; there are two between the forks of each of the upper branches of the externomedian vein, and one near the margin between these two forks; two larger and elongated spots occur in the same interspace with the lowest of the larger spots, at equal distances on either side of it, and the outer close to the margin of the wing; three equidistant ones are seen in the fork of the upper internomedian branch, one near the middle of the hind border, and finally two faint ones in the middle of the wing situated beneath and against the upper branches of the externomedian vein.

In the other fragment particularly studied (fig. 10) there are two large spots, as before, in the scapular-externomedian interspace, but they are more widely separated; a single large one in the interspace beneath, situated mid-way between the two; but one of intermediate size, though apparently belonging to the larger series, in the same interspace nearly half way between the inner and the margin. The smaller spots are distributed in a very irregular and evidently meaningless way; they are less frequent than in the first specimen found, but on the other hand there is a third series of mere dots, to the number of twenty or more, scattered about the apical part of the wing in the scapular area and just above it, below the apical branch of the mediastinal vein. A point unnoticed in the previous specimen, and perhaps from its preservation not discernible, is the fine but pronounced serration of the entire costal margin (fig. 9), which is armed with a close-set series of conical dentations, two or three times longer than broad, and separated by about their own width from each other; they are about 0.35 mm. long.

The wing in both specimens is of a dark brown color, the spots blackish brown, and the interspaces broken by a fine weak tracery of delicate irregular veins, having a general transverse disposition.

The smaller fragment is 57 mm. long and 23.5 mm. broad; the larger 55 mm. long and 46 mm. broad, the latter being the breadth of the wing, the length of which was not far from 80 mm. The smaller fragment appears to belong to an even larger wing.

The original specimen was sent to me by Prof. A. H. Worthen, through Mr. L. Lesquereux, and came from Mazon Creek, Ill. The smaller came from the same place and was sent me for study by Mr. Lacoe, in whose collection it bears the number 2025.

Meganthentomum formosum.

Acridites formosum GOLD., Fauna Saraep. Foss., II, 18-20, pl. 2, fig. 18.
Megathentomum formosum SCUDD., Proc. Bost. Soc. Nat. Hist., XVIII, 359.

This species differs from the preceding in the absence of spots and dots, and in having a more rounded and less triangular form and a more abundant branching, the externomedian vein having four principal offshoots and thirteen ultimate veinlets against scarcely more than half that number in the American form. Both have the same weak reticulation and are of about the same size.

Fischbach, Germany.

[Hemipteroid Palaeodictyoptera.]

A

Eugereon Böckingi.

Eugereon Böckingi DOHRN, Palaeontogr., XIII, 333–340, pl. 41.
Permian deposits of Birkenfeld, Germany.

B

Fulgorina Ebersi.

Fulgora Ebersi DOHRN, Paleontogr., XVI, 131-133, pl. 8, fig. 2.
Fulgorina Ebersi GOLD., Faun. Saraep. Foss., II, 28-30, 51, pl. 1, figs. 16-17.
Carboniferous deposits of Saarbrücken, Germany.

Fulg. lebachensis Gold. and *F. Klieveri* Gold. are probably hind wings of Palaeoblattariae. I may remark that Goldenberg left behind him a drawing, now in my possession, in which he tried to restore the latter so as to make it fit the wing of a Gerablattina. *Macrophlebium Hollebeni* Gold. seems to me also most probably the hind wing of a cockroach, and the supposed separation line between a basal and distal area (corium and membrane) an accidental circumstance.

C

The two forms conceded above to belong in this section of Palaeodictyoptera seem to foreshadow the homopterous rather than the heteropterous division of hemipterous insects. The reverse is the case with the interesting species next to be described.

Phthanocoris occidentalis (φθάνω, κόρις) gen. et spec. nov. Pl. 18, fig. 4.

Phthanocoris occidentalis Scudd., Proc. Bost. Soc. Nat. Hist., xx, 58-59.

A perfect front wing of moderately large size, nowhere very broad, and less than three times as long as broad. The corium occupies rather more than three quarters of the wing, separated from the membrane by an oblique sinuous line running from a point on the lower margin about three-fifths the distance from the base, and reaching the costal margin only a little before the tip. Beyond the basal fourth the costal margin is very regularly and gently arched. The inner margin is strongly rounded next the base, beyond that to the end of the corium straight, with a scarcely perceptible turn outward where it strikes it; beyond this forming with the apical margin a regularly convex curve, the apex of the wing falling in the middle of the upper two-thirds and the greatest breadth of the wing being twice its width near the base. All the principal veins are stout and prominent, but especially is this the case with the mediastinal and scapular. The marginal vein forms the costal border. The mediastinal is simple and follows the curve of the margin, constantly and very gradually approaching it and finally blending imperceptibly into it just before the extremity of the corium, or in the middle of the downward slope of the margin. The scapular vein is the stoutest and most prominent in the wing; it originates scarcely above the middle of the base (the mediastinal midway between it and the margin), and runs parallel to the mediastinal until it divides, a little beyond the basal third of the wing; its inferior branch here recovers the straight course of the extreme base of the vein and retains it to the extremity of the corium, scarcely turning upward at the end and gradually losing its prominence; while the upper branch or main vein curves upward, very gradually and very slightly approaching the mediastinal vein until it reaches the upper limit of its convexity, and then runs parallel to it, terminating in the margin at the extremity of the corium. The externomedian vein originates just below the middle of the base of the wing and runs in a straight course down the middle of the wing to the end of the corium; it is the least prominent vein in the wing but occupies most space, filling the area below it with somewhat approximate, parallel, straight, oblique veins, most or all of which originate from a principal branch which runs parallel and near to the main vein. The internomedian vein, or sutura clavi, runs from the base of the last vein to the inner extremity of the corium a little beyond the end of the middle third of the wing in a straight line, curving very slightly

toward the margin at the extremity of its course. The anal vein, starting from the same point, runs parallel to the inner margin throughout its basal curve and as far from it as the mediastinal from the marginal, and after that runs in a straight line to the tip of the sutura clavi, or almost exactly parallel to the inner margin. The margin of the membrane is filled from a quarter to a third its breadth with crowded, parallel, straight veinlets, which appear to arise vaguely from irregularly arborescent interlaced veins originating from the margin of the corium, at subequidistant intervals, which are about equal to those between the oblique branches of the internomedian vein. The surface of the clavus and corium has a minutely wrinkled appearance, not shown in the figure, formed of faint, crowded, transverse lines; these are most distinct upon the clavus; the surface is of a pale brown color, a little iridescent excepting where along some of the veins it appears to be covered with a clay brown film. The length of the wing is 15.75 mm., and its greatest breadth 5.75 mm.; a minute fragment of the tip is all that is not preserved.

It was found in the upper coal measures of Kansas City, Mo., in a small nodule in the blue and bituminuous shales, forming layer 95 of the general section given by Broadhead in Pumpelly's Geological Report, II, 88-97 (1873), and was received for examination from Mr. R. D. Lacoe under the number 2030.

The discovery of this fossil in carboniferous beds is a very remarkable one, for up to its discovery not only was no hemipteron known from rocks earlier than the tertiary in America, but no heteropterous hemipteron had been found anywhere in paleozoic formations. Yet the structure of the wing shows it to be distinctively heteropterous. The separation of the corium and membrane and the differential character of their structure is as clearly marked, apparently, as in existing types; the corium, it is true, is usually large in proportion to the membrane, and the clavus is very narrow; moreover while unquestionably divided into areas as in modern Heteroptera, their characters are very different. The sutura clavi for instance, instead of arising far toward the costal margin above the middle of the base of the wing, originates as in most ancient insects considerably below it; and the clavus, instead of being a broad field of a quadrangular shape (the opposing suturae clavi often forming a secondary triangular projection similar to the scutellum), is a narrow, elongated, triangular field of very slight importance and scarcely affecting the shape of the wing, especially as the sutura clavi terminates not before but at the extremity of the corium. Then the membrane, as stated, is very small, somewhat as in Zaitha, and indeed there is no group of Heteroptera to which it can be so well compared as to the aquatic reduvioid subfamily Belostomidae, one of the lowest groups of Heteroptera, though it certainly cannot be brought within the limits of any existing family. Another striking feature is the basal width of the margino-mediastinal, and mediastino-scapular interspaces, a feature almost or quite unknown in Heteroptera though not so uncommon in the Homoptera. We see, therefore, in the structure of this wing inherent signs of its antiquity — of its alliance to the earliest types of Homoptera and of less degree of divergence from other ancient types. No signs whatever of any approach to an embolium or cuneus are present, showing that in this as in other respects differentiation of the wing had not proceeded very far. Still the actual differentiation into the three grander areas is an indisputable fact which is very surprising; and adds another to the many startling instances already known, where a deep seated difference of structure has appeared abruptly so far as any evidence in wing structure or discovery in the rocks can point out.

A few species which have been mentioned, figured or described as coming from paleozoic rocks have not been introduced above and may here be briefly referred to : —

Euephemerites primordialis Scudd. (Proc. Bost. Soc. Nat. Hist., XIX, 248–249), is no insect at all, but the half of a leaf of Cyclopteris.

The three species which I described briefly and figured poorly in the Geol. Surv. Ill., vol. III, under the generic name of Ephemerites (wrongly printed Euphemerites) are also probably plants.

Libellula carbonaria Scudd. (Can. Nat., (2) VIII, 88–89, fig.), as a recent examination shows, is more probably the abdomen of an Arachnid, one of the Anthracomarti.

Termitidium amissum Gold. (Faun. Saraep. Foss., II, 17, pl. 1, fig. 6), is too fragmentary to be of any value, and it would be impossible to determine its position.

Termitidium rugosum Gold. (Ibid. pl. 1, fig. 14), which Dohrn first described as perhaps the remains of an orthopteron (Palaeontogr., XVI, 134, pl. 8, fig. 4), shows no vein attachments, and is, therefore, of very uncertain position.

Corydaloides Scudderi Brongn., (Bull. Seances Soc. Ent. France, 1885, p. xiii) has not yet been figured and the description of it is only provisional, so that its precise position cannot be discussed at present. A photograph Mr. Brongniart has kindly sent me shows that it is an interesting insect.

I venture to add the figure of an obscure fossil (pl. 18, fig. 2) showing most of the veins of the two overlapping wings, but generally without their attachments, so that their relation to each other cannot be determined; it is impossible to say until further material is at hand where it belongs. It was found by Mr. R. D. Lacoe near Pittston, Penn., in coal C of the Boston Mine and bears the number 2029 in his collection.

A species to which I had given the MS. name of *Termes longitudinalis* (see Lacoe's list of paleozoic insects, p. 15) is omitted here, because from an accidental circumstance it could not be obtained for reëxamination before the plates went to the engraver. It is not a Termes and will be considered on a future occasion.

Explanation of the Plates.

Plate XV.

Fig. 1. *Gerapompus blattinoides*, ¾, Mazon Creek, Ill. Drawn by J. H. Blake.
Fig. 2. *Archegogryllus priscus*, leg, ¾, Talmadge, Ohio. Drawn by S. H. Scudder.
Fig. 3. *Archegogryllus priscus*, wing, 1½, Talmadge, Ohio. Drawn by J. H. Emerton.
Fig. 4. *Eucaenus ovalis*, ¾, Mazon Creek, Ill. Drawn by Katherine Peirson.
Fig. 5. *Gerapompus extensus*, ¾, Mazon Creek, Ill. Drawn by Katherine Peirson.
Fig. 6. *Didymophleps contusa*, 1, Vermilion Co., Ill. Drawn by J. S. Kingsley.
Fig. 7. *Cheliphlebia elongata*, ¾, Mazon Creek, Ill. Drawn by Katherine Peirson.
Fig. 8. *Gerapompus extensus*, ¾. Mazon Creek, Ill. Drawn by Katherine Peirson.
Fig. 9. No. 2055. See p. 289, ¾, Mazon Creek, Ill. Drawn by S. F. Denton.
Fig. 10. *Dieconeura rigida*, ¾, Pittston, Penn. Drawn by J. S. Kingsley.
Fig. 11. *Genopteryx constricta*, ¾, Mazon Creek, Ill. Drawn by Katherine Peirson.

Plate xvi.

Fig. 1. *Anthracothremma robusta*, No. 2052, ⅔, Mazon Creek, Ill. Drawn by Katherine Peirson.
Fig. 2. *Genentomum validum*, front wing, ⅔, Mazon Creek, Ill. Drawn by Katherine Peirson.
Fig. 3. *Genentomum validum*, hind wing, ⅔, Mazon Creek, Ill. Drawn by Katherine Peirson.
Fig. 4. *Dieconeura arcuata*, ⅔, Mazon Creek, Ill. Drawn by Katherine Peirson.
Fig. 5. *Anthracothremma robusta*, No. 2052, ⅔, Mazon Creek, Ill. Drawn by Katherine Peirson.
Fig. 6. *Anthracothremma robusta*, No. 2048, ⅔, Mazon Creek, Ill. Drawn by Katherine Peirson.
Fig. 7. No. 2018. See p. 293, ⅔, Mazon Creek, Ill. Drawn by Katherine Peirson.
Fig. 8. *Cheliphlebia carbonaria*, ⅔, Mazon Creek, Ill. Drawn by Katherine Peirson.

Plate xvii.

Fig. 1. *Polyernus laminarum*, 1, Pittston, Penn. Drawn by J. H. Emerton.
Fig. 2. *Chrestotes lapidea*, 1, Mazon Creek, Ill. Drawn by S. H. Scudder.
Fig. 3. *Propteticus infernus*, anterior extremity, reverse of fig. 4, ⅔, Little Vermilion River, Ill. Drawn by J. H. Blake.
Fig. 4. *Propteticus infernus*, reverse of fig. 3, ⅔, Little Vermilion River, Ill. Drawn by J. H. Blake.
Fig. 5. *Gerarus Danae*, 1, Mazon Creek, Ill. Drawn by S. H. Scudder.
Fig. 6. *Gerarus vetus*, a little enlarged, Mazon Creek, Ill. Drawn by S. H. Scudder.
Fig. 7. *Pachytylopsis Persinairei*, ⅔, Mons, Belgium. Drawn by S. H. Scudder from the heliotype published by DeBorre.
Fig. 8. No. 2050. See p. 306, ⅔, Mazon Creek, Ill. Drawn by Katherine Peirson.
Fig. 9. *Aethophlebia singularis*, ¾, Mazon Creek, Ill. Drawn by Katherine Peirson.

Plate xviii.

Fig. 1. *Megathentomum pustulatum*, 1, Mazon Creek, Ill. Drawn by S. H. Scudder.
Fig. 2. No. 2029. See p. 314, ⅔, Pittston, Penn. Drawn by J. S. Kingsley.
Fig. 3. No. 2016. See p. 308, ⅔, Mazon Creek, Ill. Drawn by Katherine Peirson.
Fig. 4. *Phthanocoris occidentalis*, 1, Kansas City, Mo. Drawn by J. H. Blake.
Fig. 5. See p. 309, ⅔, Mazon Creek, Ill. Drawn by J. S. Kingsley.
Fig. 6. *Adiphlebia Lacoana*, ⅔, Mazon Creek, Ill. Drawn by S. F. Denton.
Fig. 7. *Gerarus mazonus*, ¾, Mazon Creek, Ill. Drawn by J. S. Kingsley.
Fig. 8. *Polyernus complanatus*, reverse of fig. 11, ⅔, Mazon Creek, Ill. Drawn by S. F. Denton.
Fig. 9. *Megathentomum pustulatum*, showing the serration of the costal margin of fig. 10 near tip, 4, Mazon Creek, Ill. Drawn by J. S. Kingsley.
Fig. 10. *Megathentomum pustulatum*, 1, Mazon Creek, Ill. Drawn by J. S. Kingsley.
Fig. 11. *Polyernus complanatus*, ⅔, reverse of fig. 8, Mazon Creek, Ill. Drawn by S. F. Denton.

Winged Insects from a Paleontological Point of View, or the Geological History of Insects.

THE division of hexapod insects into orders has undergone no very striking changes since the time of Linné and Fabricius, the founders of entomological science; new elements, indeed, have entered into their definitions, but the main divisions introduced by these pioneers have, on the whole, stood the test of time and increasing knowledge in a somewhat remarkable way. Unquestionably this is due in large measure to a somewhat unusually sharp delimitation of most of the main groups, recognized even by the least observant, who, if given a thousand chance insects from his own neighborhood, would be pretty sure to separate from one another the wasps, the moths, the flies, the beetles, etc., or at least most of them. There are, of course, a few forms (few, compared to the mass) which would prove disturbing elements, and there are some concerning which the best informed are not wholly agreed. There are also some groups about whose taxonomic value there is still disagreement, such as whether the Heteroptera and Homoptera should be looked upon as orders or as primary divisions of the order Hemiptera; others concerning which there is some dispute whether they should be separated as orders, or as mere families of one of the long established orders, instances of which may be found in the Westwoodian orders of Aphaniptera and Euplexoptera; still others, not regarded as distinct orders, concerning whose nearest affiliation there is or has been question—as in the case of the so-called Pseudoneuroptera. This is in effect only to say that here, as in other great zoological divisions, there are aberrant groups, and the main groups themselves are unequally delimited.

The attempts, however, to group the orders into larger divisions still subordinate to the grand hexapod type have resulted in very diverse presentations, according as one or another set of organs, or other peculiarities, were deemed of prevailing weight. The two which have found the most adherents have been that which separated the mandibulate from the haustellate insects, and that which divided them from each other according as their metamorphosis is complete or incomplete. To the first, the objection naturally arises that it places the Hemiptera beside the Hymenoptera, Lepidoptera and Diptera, rather than with the Coleoptera and Orthoptera, to which by all other points in their bodily structure and by their metamorphoses they are certainly far more closely allied. To the

latter, that we find very varied forms of metamorphosis within the limits of a single order, so that it would require a dismemberment of the orders to uphold the distinction in a logical form.

In the attempts alluded to above, naturalists have simply selected, as it were, combinations of acknowledged ordinal peculiarities in order to form and distinguish their superordinal divisions, and have failed to search deeper into the general structure for more fundamental characteristics. Packard, however, has done this, and by employing the terms Metabola of Leach, in a modified sense, and Heterometabola, has brought the Hymenoptera, Lepidoptera and Diptera under the former, and the other orders under the latter. In a paper published six years ago on the Early Types of Insects, I gave my adhesion to this view, and strengthened it, as I believe, by some additional characteristics drawn from the regional divisions of the trunk. In the Metabola, the thorax, supporting the organs of aerial locomotion—a primary feature of the Hexapoda as a whole—is very highly organized and compact, well differentiated from both head and abdomen, the prothorax very small; the body is generally cylindrical; the mouth parts prolonged into a beak of some sort, and the mandibles rarely opposed at tip; the front wings are membranous and larger, generally very much larger, than the hind pair; the larva is cylindrical and in no way resembles the adult, and the pupa is inactive. In the Heterometabola, on the other hand, the prothorax is large, and the joints of the thorax are less compacted, as a rule, than in the Metabola, or, if compacted, generally massively soldered to the abdomen; the body is usually flattened; the mouth parts are generally not prolonged into a beak, and the tips of the mandibles are generally opposed; the front wings are generally more or less coriaceous or with very numerous and thickened veins, and generally smaller than the hind wings; the larva is usually depressed, often resembles the adult in form (excepting, of course, in the wings), and the pupa may be active or inactive.

The exceptions, in special points, to the above general statements, are not few, especially among the less homogeneous Heterometabola, but if any superordinal division of Hexapoda is to be looked for, it would seem to be on the lines here indicated. The points which are especially disturbing are the opposition of the mandibles in the Hymenoptera, and the appearance of many metabolous characteristics among the Neuroptera properly speaking, a group which is, nevertheless, as a whole, admittedly related most nearly to other heterometabolous orders.

That the Metabola should rank, as a whole, higher than the Heterometabola, can scarcely be disputed; the regional division of the body, the structure of the wings for flight, and especially for strong and directed flight, the complication of the mouth parts, and the universally complete metamorphosis and quiescent pupal state,—are fundamental features, in which the hexapodal type is carried, as a whole, to its highest development. And yet, as we shall see, there are some features in which its members have held to fundamental characteristics of paleozoic hexapods more firmly than have most of the heterometabolous groups.

This brings us fairly to the main object of this paper. What were the relations of the ancient to the modern types of winged insects? In what succession did the two superordinal divisions of insects appear, and at what period the different orders as we now recognize them? What light, in short, can paleontology throw upon the origin and succession of insects?

In attempting some years ago, in a paper already referred to, to answer this question in a broad way, I stated that all the orders of Heterometabola, and none of Metabola, had been found in paleozoic deposits. To-day I shall have to modify this proposition. Not only have numerous discoveries been made in paleozoic deposits within the past six years, but those already known have been subjected to more rigorous study and wider comparisons, which have considerably enlarged our knowledge. Protophasma had then only just been discovered, an insect which has done more than any other, excepting Eugereon, to throw light on the fundamental characteristics of the early world of insects; and even now Brongniart has published but five or six examples of the treasures of Commentry, a place which has already yielded remains exceeding in numbers those of all the rest of the world put together. Nor must we leave out of sight his discovery of a winged insect in the Silurian.

While our knowledge of paleozoic insects is thus shown to be clearly still in its infancy, it may appear hazardous to attempt to formulate statements of a broad and sweeping character concerning the appearance of the primary groups of insects in paleozoic times, especially if I am already compelled within six years to modify such assertions then made. Yet when I point out the nature of this modification, made after a special study of every known paleozoic form, it will appear less hazardous.

The modification I would introduce is to this effect: That while we may recognize in the paleozoic rocks insects which were plainly precursors of existing Heterometabola, viz.: Orthoptera, Neuroptera (both Neuroptera proper and Pseudoneuroptera), Hemiptera (both Homoptera and Heteroptera), and perhaps Coleoptera — and no Metabola whatever — a statement almost identical with that previously made, we may yet not call these Orthoptera, Neuroptera, etc., since *ordinal features were not then differentiated;* but all paleozoic insects belonged to a single order which, enlarging its scope as outlined by Goldenberg, we may call Palaeodictyoptera; in other words, the paleozoic insect was a generalized Hexapod, or more particularly a generalized Heterometabolon. Ordinal differentiation had not begun in paleozoic times.

It will be asked, were there then no cockroaches in paleozoic times? I answer, yes; cockroaches but no Orthoptera; Palaeoblattariae, not Blattariae; that is, Palaeodictyoptera, not Orthoptera. Mayflies; but they were Palephemeridae, not Ephemeridae—again, not Neuroptera but Palaeodictyoptera. Walking sticks; but no Phasmida—only Protophasmida, another group of Palaeodictyoptera.

The grounds for this view are as follows: 1. No group of paleozoic insects has yet been studied carefully—and it is important to observe that, though our knowledge of them is of necessity fragmentary, yet the more perfectly they are known the clearer is this true—no group, I say, has been carefully studied which does not show, between it and the modern group which it most resembles, differences so great that it must be separated from that group as a whole, as one of equal taxonomic rank, as in the case of the three related groups last mentioned.

2. That the different larger groups of paleozoic times, of which we now know nine or ten, were more closely related to one another, at least in the structure of their wings (which is the only point of general structure yet open for comparison), than any one of them is to that modern group to which it is most allied, and of which it was with little

doubt the precursor or ancestral type. Thus the Palaeoblattariae are more nearly allied in the ground structure of their wings to certain neuropteroid Palaeodictyoptera of paleozoic times than to the modern Blattariae; and yet we can so completely trace in mesozoic times the transition from the Palaeoblattariae to the Blattariae, that no reasonable doubt can exist as to their descent, the one from the other.

3. The ordinal distinction which is now found in the wing structure of modern insects did not exist in paleozoic insects, but a common simple type of neuration which barely admitted of family division.

It will appear from this that, by a sort of principle of family continuity, we may recognize in the paleozoic insects a tendency toward a differentiation in ordinal characters, sufficient to enable us in an *ex post facto* fashion to distinguish between orthopteroid, neuropteroid, etc. Palaeodictyoptera.

In speaking above of the different orders of Heterometabola which were foreshadowed in ancient times, I included the Coleoptera with a limitation, for the following reasons: Troxites, the only supposed paleozoic beetle which has not been shown to be an arachnid, is a very obscure object, and is very likely, as Brongniart has suggested, to be merely some fruit. But there have been found wood borings of different kinds which so nearly resemble similar excavations made now by Coleoptera that it is natural, though of course not necessary, to attribute these to them. Yet if Coleoptera, with front wings differentiated as those of to-day existed then, it would be rather anomalous, since all the paleozoic insects we know excepting one, Phthanocoris, which foreshadowed the heteropterous Hemiptera, had fore wings as completely membranous as the hind wings.

It seems to me probable, therefore, though there are no further grounds for it than those just given, coupled with the present relationship of the Coleoptera to other Heterometabola, that Coleoptera sprang from such Palaeodictyoptera as were wood-borers throughout the greater part of their life, and which at first showed no greater distinction between the front and hind wings than existed generally in other Palaeodictyoptera; but afterward those races were preserved in which the thickening of the membrane of the upper wings the better protected the insects while in their burrows for the marriage flight in open air. Their habits would render their preservation in the rocks less frequent, and this special differentiation would be likely to proceed rapidly, and to be retained even by those which lost the wood boring habit;—a habit, by the way, likely to have existed with some insects living in the vast carboniferous forests.

Of the metamorphoses of the paleozoic insects we know absolutely nothing, for no larval or pupal form has yet been found, nor even any apterous insect[1] which might by any possibility be looked upon as such. The preparatory stages of existing Heterometabola; the fact that from every form of evidence the more "complete" metamorphosis must have been derived from the less complete; and the generally admitted proposition of Brauer and others that metamorphosis, that is, radical change of form after birth, is a secondary adaptive feature;—these all lead us to conclude that the only significant change in the paleozoic Palaeodictyopteron after leaving the egg was the acquirement of wings; and that the acquirement of wings was the lever which natural selection handled to procure the present varied forms of metamorphosis in insects.

[1] Polyxesterites of Goldenberg is looked upon as a crustacean.

A curious and somewhat unexpected fact is found in the present universal prevalence of membranous front wings in all the orders of Metabola, similar to what is found in the direct paleozoic ancestors of Heterometabola; while most existing Heterometabola, though lower in general organization than the Metabola, have passed beyond this feature of uniformity to one of greater differentiation, the front wings being more or less coriaceous, while the hind wings are still membranous. This, together with the direct relation of some paleozoic insects to later types, would lead us to believe that we are to look at the neuropteroid Palaeodictyoptera as the ancestors not only of later Neuroptera but also of all Metabola, and would account in a measure for the somewhat close relationship of the Phryganidae and lower Lepidoptera.[1]

Allusion has been made to Brongniart's discovery of an insect's wing in the middle Silurian — a long way removed from the upper Devonian, which had hitherto been their lowest known horizon. But though he quickly published a rude figure of his fossil, it is insufficient for critical purposes, and it would probably be hard to obtain from a single discovery the clew we need as to the ancestry of the Palaeodictyoptera. We may safely conclude, however, that the winged Palaeodictyoptera came in as early as the middle Silurian and that up to the close of the paleozoic epoch their divergent stems were still admissible into one general order.

Now when we look at the insects of later formations, we find types of every one of the existing orders of insects — speaking of these orders in their broadest sense, as we have everywhere done in this essay — we find every one fully developed in the Jurassic period.

In the Orthoptera we find as good a proof as anywhere, since cockroaches are the only insects found in any numbers in the very lowest mesozoic rocks. Their presence in the Trias and its significance will be alluded to later. In the Jurassic rocks nearly forty species are known, of which about one-third are in the lower Jurassic, and nearly all are true Blattariae. So too in the Liassic rocks we recognize all the families of saltatorial Orthoptera and the Forficulariae, so that the Orthoptera may be considered as well established early in mesozoic times. Unfortunately no Phasmida have yet been recovered.

Only one or two Neuroptera have been recognized in the Trias, but in the Lias we have a considerable number, including Megaloptera, Sialina, Panorpidae, Phryganidae, Ephemeridae, Termitina and Odonata, showing that the differentiation into the non-existing families was apparently complete early in mesozoic times, and that forms of nearly all recognized families were abundant in the middle and later Oolite.

The two orders just mentioned are almost the only ones that have yet been recognized in the scanty fauna of the Trias, but the moment we reach the lower Jurassic rocks we find traces of nearly all the others; thus several families both of Homoptera, and of Heteroptera are found in Liassic rocks, including such diverse types as the Coreidae, Belostomidae, Cicadina and Cicadellina, while Fulgorina and Aphidina are added in the Oolite.

The Coleoptera, of which we found only indefinite traces in paleozoic rocks, have been found in the Trias (Chrysomelites), and the adjacent Rhaetic has disclosed forms as different as Hydrophilites, Buprestites and Curculionites, while the Lias already claims some one hundred and twenty-five species referred to as many as seventeen distinct families.

[1] In this connection it would be well to call attention to one of Dr. A. S. Packard's early papers on Neuroptera as a "synthetic type." See Bost. Journ. Nat. Hist., VII, 590.

When we come to the metabolous orders we find a scantier representation, but in the more limited sense necessarily attendant upon this fact nearly the same things are true. Three or four species of Diptera, referred to Chironomidae, Tipulidae, and Asilidae, are found as low down as the Lias, about as many more in the middle Oolite, and some fifteen or twenty in the upper Oolite, of several different families, mostly Nemocera. Of Lepidoptera, the remains of which are exceedingly scanty even in the tertiaries, we know of two unquestionable Sphingidae in the middle Oolite, and the mines of a tineid moth in the Cretaceous. While of Hymenoptera we have eight or ten mesozoic species, the oldest of which is an undoubted ant from the Lias, next a wood wasp and four or five very obscure remains from the middle Oolite of Solenhofen, two ants again from the upper Oolite (Purbecks), and the eggs of one of the Tenthredinidae from the Cretaceous.

We find then that the entire change from the generalized hexapod to the ordinally specialized hexapod was made in the interval between the close of the paleozoic period and the middle, we may say, of the mesozoic. These significant changes were ushered in with the dawn of the mesozoic period, and the Triassic rocks become naturally (together with the Silurian) the most important, the expectant, ground of the student of palentomology Hitherto for fifty years the Carboniferous period has claimed this interest as its birthright.

The Silurian period has furnished only a single insect, just discovered and already alluded to. The Triassic has four or five representatives in the Old World, while a new locality recently made known in Colorado has yielded a considerable number of specimens of about twenty species, mostly still unpublished. Most of these are cockroaches, and they illustrate and enforce the conclusion we have reached in an interesting way. One of them, the European Legnophora of Heer, shows for the first time in the history of cockroaches[1] a thickening of the front wings, rendering the veins nearly obsolete, a characteristic of Blattariae (not always very striking) but never found in Palaeoblattariae. A similar appearance is to be seen in a few of the American cockroaches of the Trias, and in addition to this they are divided between Blattariae and Palaeoblattariae, and the passage from one to the other is traceable. The two exist side by side, but some of the Blattariae have the front wings equally membranous.

It would then appear that the geological history of winged insects, so far as we know from present indications, may be summed up in a very few words. Appearing in the Silurian period, insects continued throughout paleozoic times as a generalized form of Heterometabola which for convenience we have called Palaeodictyoptera, and which had the front wings as well as the hind wings membranous. On the advent of mesozoic times a great differentiation took place, and before its middle all of the orders, both of Heterometabola and of Metabola, were fully developed in all their essential features as they exist to-day, the more highly organized Metabola at first in feeble numbers, but to-day and even in Tertiary times as the prevailing types. The Metabola have from the first retained the membranous character of the front wings, while in most of the Heterometabola, which were more closely and directly connected with paleozoic types, the front wings were, even in mesozoic times, more or less completely differentiated from the hind wings, as a sort of protective covering to the latter, and these became the principal organs of flight.

[1] Etoblattina insignis Goldenb., sp., may, perhaps, be an exception, but the apparent thickening may be due to poor preservation, as the hind wings share fully the same characteristic. Is it possibly a "pupal" form?

The oldest known Insect-larva, Mormolucoides articulatus, from the Connecticut River Rocks.

PROFESSOR Edward Hitchcock, who published so extensively upon the footprints found in the sandstones of the Connecticut River was the first to make known the presence in the triassic shales at Turner's Falls, Mass., of insect remains.[1] These he first mentioned in his report on fossil footmarks published by the state in 1858, giving illustrations upon one of his plates, which are too obscure to be of any value. Judging the creature to be a crustacean, he sent specimens to Prof. J. D. Dana of New Haven, who, in a letter published in this volume by Professor Hitchcock, considered it to be "probably a larva of a neuropterous insect," and sent to Hitchcock the cut we here reproduce, in which he regards *A* as the head, *B* to *C* as thoracic, and *C* to *D*, abdominal segments. This, reduced, is the figure given in Dana's Manual of Geology.

Fig. 1, Mormolucoides articulatus Hitchcock.

Some years after this, the late Dr. J. L. Leconte, having expressed the opinion from an examination of the figures alone, that Professor Dana was correct in his judgment of the neuropterous character of these remains, and having further referred them more definitely to the Ephemeridae, Dr. Hitchcock, who never lost the opportunity of changing the name of a fossil, if he thought he could thereby indicate more closely its affinities, proposed that the name of *Mormolucoides articulatus*, he had at first given it, should be altered to *Palephemera mediaeva*. The first name, being in no sense misleading, must, of course, be retained, and indeed fortunately, since this is not the end of the opinions which have been held (and may perhaps yet be held) regarding it.

Having an opportunity some years since, of studying a slab lent me by Prof. O. C. Marsh, containing twenty or thirty individuals, and of comparing them with others in the Museum of the Boston Society of Natural History, I published my views of the structure and relationship of this fossil larva in the Geological Magazine of London, in which I came to the conclusion that they were coleopterous larvae, and suggested that they "remind one of some Cebrionidae," but the only larva of that group whose history is known "lives on the roots of plants and would not be likely to occur in

[1] *Mormolucoides articulatus* Hitchcock, Ichnol. N. Engl., pp. 7-8, fig., Pl. 7, figs. 3-4.—Dana, Ibid.—Scudder, Proc. Bost. Soc. Nat. Hist, xi, p. 140; Id., Geol. Mag., v, pp. 218-20.
Palephemera mediaeva Hitchcock, Amer. Journ. Sc., [2] xxxiii, p. 452.—Packard, Bull. Essex Inst., iii, p. 1.

such a deposit as that in which these remains were found." In this communication, finding among the specimens I examined none with any lateral appendages, I concluded that the figures which had been given were inaccurate in that particular, a conclusion based, as will be seen, on insufficient material.

A few years later, Dr. A. S. Packard published a short note upon them, in which he expressed the opinion that they were "aquatic coleopterous larvae, belonging perhaps near the family Heteroceridae."

It will thus be seen that some difference of opinion has been expressed concerning the affinities of these fossils, though they have uniformly been considered larvae, and as belonging either to Neuroptera or Coleoptera.

Having recently been able through the kindness of Professors Emerson and Hitchcock to examine the considerable collection of these remains in the cabinets of Amherst College, and by favor of Professor Marsh to study all the specimens in the Yale Museum, I have examined with care some hundreds of these larvae, and reviewed the whole subject anew. Notwithstanding the considerable differences which show themselves, I am strongly convinced that all the specimens I have studied belong to a single species, differing somewhat in structure from what I formerly believed, and whose affinities are pretty clearly different from what I formerly supposed, several new features, not before observed, being now apparent. This point, however, will be discussed after the structure has been set forth in full.

The body is composed of thirteen apparent segments, of which the head forms one, and three are differentiated, sometimes very obscurely, as thoracic. The statement that the head forms but a single segment is at variance with my former conclusion, for the two segments of the description then given by me form together what I now look upon as the head. There are doubtless a good many specimens which lend color to my former conclusion, and I reproduce upon the plate (fig. 3), a copy of a drawing made fifteen or more years ago of what I then considered the first three segments of the body. A similar development of the first segment may be seen in fig. 13, and to a much less extent in fig. 9. Whether these lateral anterior lobes of the head, always separated from it by a more or less marked suture, are inferior appendages showing only when projected forward, can hardly be determined, but this seems the most probable explanation. The decided differentiation of the thoracic segments in certain individuals (see figs. 1, 5, 14 for example) leaves no room for doubt that the smaller segment in front of them, usually single, at other times apparently double, represents the head.

The head then is a rounded segment, usually a little broader at base than in the middle (see especially figs. 12, 16) and slightly broader than long, the front well rounded. It is generally about as large as the hindmost segment of the body, but occasionally is larger than it where the final segment appears but partially extended, and in a few instances is much larger; it is then also out of all due proportion to the segments behind it, as in fig. 10, where it does not appear to be crushed and unnaturally expanded, but rather as if the lower appendages of the head, forming in other cases the protruded anterior lobes, had been laterally spread out and lay beside the head, of which, as in the other case, they seem at first sight to form an integral part. That this is the correct view is the more probable because, when the surface is not absolutely flat (as may be the case

in any fossil insect, no matter how highly irregular its surface may have been in life), the head is provided with lateral bosses, which may be partly explained as due to the underlying appendages; for when these supposed appendages are thrust forward and form the anterior lateral lobes, it is these lobes which are embossed, as described in my previous paper; while when, as in fig. 10, they are supposed to lie outside the lateral limits of the head, the protuberances are still found connected with them. What appendages these lobes may represent it would be difficult to say. One would more naturally expect such evidently corneous organs, forming bosses even where they are separated from the head, to be mandibles, but their broad and rounded shape gives no clear evidence of their use in such a way; and in such a flattened larva it could not be supposed that they formed a vertical fang, the crushing of which, from above downward, would bring all the chitinous portion together in a mass, and so produce a boss upon the stone.

The three thoracic segments are almost invariably larger, generally considerably broader than the others, and are often distinctly differentiated as a separate region, both by their breadth, greater than that of the uniform segment behind, as well as by the slight forward inclination of their sides. This appears clearly in fig. 5, but is generally less marked than there by the smallness of the hindmost thoracic segment, which is not often broader than the following abdominal segment, as in figs. 5 and 14. Usually also the middle thoracic is larger than the front thoracic segment, so that their relative size is II, I, III (see figs. 1, 11, 12, 14) but not infrequently the front one is the largest, as in figs. 5, 6, 10, and there are some cases where the broadest part of the body is behind the thoracic segments, and the order of breadth in the thoracic segments is III, II, I. In these cases, as in figs. 4, 7, 13 and particularly 9, the whole aspect of the insect is changed, and yet a careful study of the specimens leads one to the conviction that all belong to a single species. In some, of which fig. 5 may be taken as an extreme type, we are reminded, in form, of the larva of a longicorn beetle, while the other extreme, as in fig. 9, recalls rather some of the Silphidae. What may be looked upon as the average or normal thoracic segment, is about three times as broad as long, subquadrate, with very slightly concave front margin, and a little more distinctly convex hind margin, the sides well rounded and the hinder angles more broadly rounded off than the front lateral angles, giving a slight sublunate form to the entire segment. These segments are further marked by more or less distinct lateral marks, usually impressed, either angular (figs. 5, 14) or rounded (figs. 1, 10, 15), which are the only indications, if such they are, of appendages. I had thought they might be taken for the marks of very short legs, and perhaps they can; but the figures given by Schiödte of the larvae of the coleopterous genera Necrophorus, Anisotoma and Agathidium, where similar marks are purely sculptural, leave me in doubt. Every one must have seen in nature similar marks on longicorn larvae, but these are more generally mesially disposed, and do not, as here, reach so distant a point from the middle line. Whatever they are, there is nothing else on a single specimen examined by me — many hundreds in number — which could be referred to legs.

The abdominal segments invariably taper to some extent toward the tail; sometimes the tapering is scarcely visible on the anterior segments, and it is always more pronounced posteriorly, but here as before there are nearly all shades of difference between

individuals, the extremes of which may again be represented in figs. 5 and 9; in the former of these the basal abdominal segments are only about half as broad again as long, and the middle ones are about square; while in the latter, the basal abdominal segment is more than twice as broad as long and it is only the terminal segment which is square. As a very general rule, the segments are quadrate, with very gently convex sides, and slightly and equally rounded anterior and posterior lateral angles; but in a few cases, as in fig. 9, the anterior angles are considerably more rounded than usual, and the posterior angles, besides being square, are furnished with a faint posterior extension, bristle, or tapering cluster of hairs (it is impossible to say which, but the last is the most probable). This same posterior set of appendages may be seen more or less distinctly in some of the other specimens, where the segments have the posterior angle as rounded as the anterior, but otherwise resemble this fig. 9 (as in fig. 4), or in which the segments are of the normal form, as in fig. 6, which represents the specimen which apparently furnished the figure which has hitherto been current, and in which these appendages appear more decidedly as hairs, being more spread out, and also as attached to the posterior thoracic segments.

The surface of the abdominal segments is in general flat, but not quite uniform, at least on many specimens. There appear to be two kinds of inequalities, one of which from its infrequency and position seems to be accidental, perhaps due to pressure. This is seen in fig. 16, in sharp lines close and parallel to the margin. The other, however, though often obscure, is too common to be so considered, and consists in a longitudinal series of slight ridges, laterally convex, and extending the whole length of the abdomen, dividing the segments into equal or subequal transverse thirds, of which the middle third is apt to be the largest. This may be seen in figs. 1, 6, 15. Besides these, there is nearly always some median mark of greater or less intensity, indicating probably the track of the alimentary canal. Two specimens which I have figured (figs. 2, 11) show this in a marked degree, the remains of a tube which extended the entire length of the body being visible. It is much more pronounced on the abdominal segments than elsewhere, but in fig. 2 more distinct on the anterior half of the abdomen, while in fig. 11 it is more distinct on the posterior half, where it is clearly at least double, being turned upon itself between the fifth and sixth abdominal segments, forming there a distinct rounded loop, and again more obscurely on the front of the eighth segment. To correspond with this, we have in fig. 2 a distinct horse-shoe shaped depression superposed a little laterally on the median groove at the posterior end of the fifth abdominal segment, and a shallower, smaller, circular depression in which the groove appears to terminate on the front of the seventh abdominal segment. From these it would appear tolerably clear that a slender alimentary canal, nowhere expanding into a well marked stomach, doubled sharply upon itself at or near the seventh abdominal segment, and again, by doubling at the hinder extremity of the fifth abdominal segment, resumed its former course, the whole of the sixth segment and at least a part of the seventh having therefore three sections of the canal passing through the middle.

The variations in form of the different segments of the abdomen have been mentioned. It now remains to speak of the curious variations of the terminal or ninth abdominal segment and of its special appendages. The general relation of this segment to the

preceding as well as its ordinary form is shown in figs. 1, 10 and 16, where it is quadrate but well rounded, tapering and about two-thirds as large as the preceding joint. In some cases, however, as in fig. 9, it is very small, and its separation from the preceding joint hardly noticeable, while at the other extreme, as in fig. 7, it is scarcely smaller than the preceding segment and longer, if anything, than broad. But the most interesting feature in this segment is the discovery in a few specimens, as in figs. 9 and 14 and to a slight degree in figs. 2 and 16, of appendages. There is an outer pair of slender styles, a little shorter than the penultimate segment, directed backward and a little divergent; and a much shorter pair, or perhaps only projections of the pygidium, lying between the longer styles.

As there is not a single specimen among the hundreds I have seen showing a lateral or even a partially lateral view, the insect could not have been cylindrical but must have been considerably flattened. The variation in the general form of the specimens, as preserved, indicates a not very corneous or rigid integument, since the shape of single segments varies considerably. Yet the general form is as a rule so uniform (as appears in fig. 8, where a number of specimens are exhibited just as they lie on the stone, much better than my selection of other specimens to be drawn for some particular feature) that we must consider the integument to have been at least coriaceous, and the varying proportions of single segments to depend, partly at least, upon the greater or less exposure of the intersegmental membrane.

When we come to consider the probable affinities of a larva having the structure above described, we are at a loss. No living form seems to be at all nearly allied to it. It would appear on general grounds to be either coleopterous or neuropterous, and from its aquatic habit to be more likely neuropterous than coleopterous; but further than this one must tread largely on conjectural ground. The structure of the head, in which the only recognizable appendages appear to be nearly or quite globular and chitinous, the absence or extreme brevity of the legs in connection with a plainly flattened body, and a terminal segment provided with cerci, are combinations and features very extraordinary. The only coleopterous larvae which seem at all to remind one of their general appearance are the Silphidae, all the larvae of which now known prey upon decaying animal and vegetable matter or live upon fungi, and none are aquatic; the Lampyridae, which are equally out of the question; and the Heteroceridae, which have no terminal appendages. These larvae, besides having a general form somewhat resembling that of Mormolucoides, have a flattened body,[1] short legs, and the Silphidae also a small head and distinct anal cerci, besides posterior lateral extensions of, or appendages to, the abdominal segments; but they have also comparatively small and tender mouth-parts; and the Silphidae stout, jointed antennae of considerable length, while their legs are usually as long at least as the greatest width of the body; and besides the ordinary nine segments of the abdomen, there is in the Silphidae the strongly protruding pipe-like pygidium, for which there is no homologue in Mormolucoides, unless the inner pair of cerci be taken as representing a completely forked pygidium. When we add to these differences the peculiar habitat of the living Silphidae, and the similar terrestrial haunts of

[1] In Heterocerus it is cylindrical.

the Lampyridae and Heterocerida,[1] we shall be loth to assert a close affinity with these groups. Such groups of Coleoptera as have aquatic larvae show, however, no points of resemblance at all to Mormolucoides, and it seems, therefore, far more probable that they are neuropterous.

In support of this view, we have on general grounds, the flattened and posteriorly tapering form, much more common in Neuroptera than in Coleoptera, besides the terminal cerci, and posterior lateral appendages of the abdominal segments — features much more in accordance with the structure of those groups of Neuroptera to which they seem most nearly related, than with the structure of any Coleoptera.

These groups are the Perlidae, Ephemeridae and Sialidae, in all of which the larvae are at least in large part aquatic. In each of the first two of these groups, there is a remarkable uniformity of larval organization, and they seem to differ so much from Mormolucoides as to make it unwarrantable for us to look for intimate relationship with them. In Perlidae, for instance, we have a prothorax distinctly differentiated from the other thoracic segments, and the latter bearing at a comparatively early age, as in Blattariae, indications of the coming wings in the form of pad-like expansions of the outer angle of the said margin; we have also long and prominent antennae, very long and large flattened legs, anal cerci of great length, and no sign of an inner pair of cerci. In Ephemeridae, we have an entirely different form, equally discordant in its relations to Mormolucoides. The legs are nearly as long and stout as in Perlidae, lateral respiratory filaments cover the dorsum of the abdominal segments, the head bears stout, and often long antennae, while the terminal segment is almost invariably armed, not only with outer large, long, feathered anal cerci, but also with a similar, single, median style, even when the latter is absent from the imago; two inner styles are never present.

The comparative uniformity of larval structure among the diverse genera of each of these two groups prevents us from believing that Mormolucoides with its very different structure could by any possibility be included in either of them. Not a trace of thoracic wing pads or abdominal respiratory filaments can be seen on the hundreds of specimens examined. The great length and size of legs and multiarticulate antennae in both the groups, find no counterpart in Mormolucoides, and the appendages of the terminal segment are altogether different.

Not so, however, or not by any means to so great an extent, when we compare the larvae of Sialidae. Here we find a considerable greater range of characteristics, so that it is not so easy to recognize a common facies among them. But we may note one or two characteristics by which they approach much more closely our fossil type. All the appendages,—antennae, legs and (often) the cerci, are shorter and slenderer than in the two groups last mentioned. In some, the antennae at least are comparatively insignificant. The mandibles in some are very stout, and though long in all that are known may well be believed to be capable of modification in this regard. The abdominal segments are provided with lateral filaments, projecting backward from the posterior outer angles. The appendages of the terminal segment vary very much, some having a single median style of considerable length, others a shorter lateral pair, in some cases furnished api-

[1] The Heterocerida live near but not in water.

cally with recurved hooks. The objections to considering this as the most nearly allied group are the considerable size of the legs even when least developed, the great size of the head, which is at least as large as the segments behind, and the slight differentiation of the prothoracic segment shown at least in its larger size.

I had reached the conclusion that upon the whole we might look upon the Sialidae at the group of insects to which Mormolucoides was the most nearly allied (though still regarding the conclusion as provisional) when it received a curious support from an unexpected quarter — the internal structure of the larva. I have said that several specimens of Mormolucoides showed traces of the alimentary canal, and that in two of them (figs. 2, 11) in the posterior part of the body it doubled twice upon itself, covering with its triplication the sixth abdominal segment and parts of others, indicating a convolution of the small intestine. Looking at the published accounts and figures of the internal organs of the larvae of the three groups of Neuroptera we have been discussing, I find that the digestive tract, so far as known, is invariably straight and simple in both Perlidae and Ephemeridae, while a triplication of the small intestine is not unknown in Sialidae, being distinctly figured and described by Leidy in *Corydalis cornutus*,[1] where it covers the fifth abdominal segment, or the one next in advance of that in which we have found it in Mormolucoides. The only other figure of the digestive tract of a Sialid larva, which I have found, is that of *Sialis lutarius* published in the same year by Dufour,[2] where it is figured as perfectly straight and described similarly as "droit comme celui de l'insecte ailé." Several species in their perfect state, in groups closely allied to the Sialidae and sometimes placed with them, such as Panorpa, have a similar triplication of the small intestine, and it is also found in the larva of Myrmeleon as figured by Dufour.[3] These seem to be fair corroborations of the conclusion independently reached, that Mormolucoides is probably the larva of a Sialidan neuropteron. It has special interest from the fact that it is the oldest known insect larva.

EXPLANATION OF PLATE 19.

All the figures represent *Mormolucoides articulatus*, and all but fig. 3 were drawn by J. Henry Blake. Fig. 8 is natural size; fig. 3 enlarged about 5 diameters; the others enlarged 3 diameters.

Fig. 1. A specimen from Montague, Mass., collected by Prof. O. C. Marsh and in the Peabody Museum of Yale College. The head is smaller than usual.

Fig. 2. From the same place and collection as the last and on the same slab as fig. 16. Although imperfect, the head and first thoracic segment wanting, it shows remarkably a sharp median groove, which can be nothing else than the digestive tract, with the indication of its twice doubling on itself at the end of the fifth and base of the seventh segments. A slight indication of one of the anal styles is also seen on the last segment.

Fig. 3. The head and first thoracic segment of a specimen in the Yale College Museum, as drawn, many years ago, by S. H. Scudder. It shows the apparent division of the head into two segments, then supposed to be head and first thoracic segments.

Fig. 4. Specimen from Montague, Mass., collected by Professor Marsh and now in the Peabody Museum at New Haven. It shows a head of unusual breadth, basal abdominal segments which are larger than the thoracic, and slight indications of the lateral appendages of the abdomen.

Fig. 5. Specimens from Turner's Falls, Mass., marked No. 1,405 in the Shepard collection of Amherst College. Figs. 11 and 12 are on the same slab. This specimen shows well the lateral marks of the thoracic segments interpreted as possibly legs, a well marked differentiation of the thoracic and abdominal segments, and an unusually uniform breadth in the latter.

Fig. 6. This specimen appears to be the original type of *Mormolucoides articulatus*. It is on the same slab with fig. 15, marked as coming from the Horse Race, Gill, and numbered ‡‡ in the Amherst College collection. There is not more

[1] Mem. Amer. Acad., IV, 162–168, Pl. 1, 2(1848).
[2] Ann. Sc. Nat. (3), IX, 91-99. Pl. 1 (1848).
[3] Mem. Sav. Etrang. Acad. Sc., VII, Pl. 12, figs. 175, 177 (1841).

than one other slab in the collection which bears a very old printed label with the original name, and this specimen is the only one in which the lateral appendages are distinct. It has, moreover, been tooled to some extent and bears no small resemblance to the figures in Hitchcock's plate. Apart from its interest it would have been drawn at this time if only to show the lateral appendages of the abdomen, which seem here to be supplied also to the last thoracic segment.

Fig. 7. Unlabelled slab in the Amherst College Cabinet. Remarkable for the very small size of the thoracic segments, which are not only narrower than the anterior, but no wider than the posterior abdominal segments. It is the only specimen I have seen showing such a feature, and is the more marked because the thoracic segments are, if anything, shorter than usual. Figs. 9 and 13 are on the same stone.

Fig. 8. A slab from Montague, Mass., numbered 1,637 in the Yale College Museum and collected by Prof. O. C. Marsh. This is figured to show the abundance of larvae on a single stone, although other instances could have been given where they are two or three times as numerous. This was selected simply on account of the small size of the slab. The specimen marked *a* is represented enlarged in fig. 10.

Fig. 9. Specimen from the same slab as figs. 7 and 13. It is one of the most interesting seen, as it is remarkable not only for the unusually symmetrical and perfect development of both the lateral and terminal appendages of the abdominal segments, which together show in no other specimen seen, but also for the symmetrical and unusual fusiform shape of the body. The last segment is unusually small. The head too shows some signs of the frontal lobes.

Fig. 10. The specimen marked *a* on fig. 8 enlarged, in which the main interest centres in the head, which is unusually broad, apparently from a lateral displacement of the frontal lobes, as explained in the text.

Fig. 11. On the same slab as figs. 5 and 12. This is drawn to show the unusually clear doubling of the alimentary canal at the suture between the fifth and sixth abdominal segment. On the front part of the eighth segment, the left hand tube is seen to pass beneath that on the right on the commencement of its recurrent course, but it does not show clearly in the plate.

Fig. 12. On same slab with figs. 5 and 11. Head of more than the usual size, showing an unusual basal expansion.

Fig. 13. On the same slab with figs. 7 and 9. It is especially interesting on account of the fine development of the frontal lobes of the head.

Fig. 14. Specimen from the Horse Race, Gill, Mass., numbered $\frac{4}{5}$ in the Amherst College Collection. The head is unusually circular and rather small; the thoracic appendages (or sculpturing) unusually distinct and angular; the abdomen tapers with great regularity, and the last segment is supplied with all the appendages. As drawn on the plate the last segment is perhaps a little too long.

Fig. 15. On the same slab with fig. 6. The special feature is the nearly uniform size of the body throughout and the position of the head, sunken nearly out of sight within the thoracic segment behind it.

Fig. 16. From the same slab as fig. 2. The specimen is of unusual size, the head has an unusual basal enlargement, and a slight sign of one of the terminal styles is seen on the last segment.

Note on the supposed Myriapodan Genus Trichiulus.

TWO years ago I published in the Memoirs of the Boston Society of Natural History the description of a genus of supposed hairy myriapods, Trichiulus, from the beds of Mazon Creek in Illinois, of which three species were distinguished. A short time ago my attention was again called to these specimens by Mr. R. D. Lacoe, whose collection is very rich in remains both of plants and animals from the carboniferous period, and in which are all the types of the species described. Mr. Lacoe was convinced that at least two of them should be regarded as the terminal circinate portions of ferns. Dr. H. B. Geinitz of Dresden (who had made a similar mistake in regarding a frond of Scolecopteris as a myriapod, to which he gave the name Palaeojulus) also wrote me somewhat to the same effect, and I have accordingly reëxamined the original specimens by the favor of Mr. Lacoe in the light of half a dozen undoubted coiled fern-tips from his collection, sent me with them; with the result that there is no doubt whatsoever that they are ferns of the genus Pecopteris or one of its allies, preserved obscurely at the time of their partial unfolding, and that the name Trichiulus must disappear. The only specimen not reexamined is that of *T. nodulosus*, figured on pl. 27, fig. 1.

A Review of Mesozoic Cockroaches.

Six years ago, when I published a revision of all the paleozoic cockroaches then known, I was obliged to resort entirely to existing forms in the comparisons instituted between the wing structure of the ancient types and that of those of later times. Illustrations indeed and partial descriptions existed of more than thirty mesozoic forms, but since many of these were very imperfect, and many vaguely drawn, any attempt to reach definite conclusions concerning them, without specimens themselves from that period to examine, seemed futile.

It was my hope that, since structural distinctions of fundamental importance and of complete uniformity were shown to exist between paleozoic and recent cockroaches, rendering an examination of the mesozoic forms most desirable, some English naturalist would undertake the task; for it was evident, from the illustrations already given by Brodie and Westwood, that the British Lias and Oolite were especially prolific in these forms, and that abundant material must exist in public and private collections for the elucidation of the problems suggested.

This hope has not been fulfilled; but an unexpected discovery of Triassic cockroaches in considerable abundance in the South Park of Colorado rendered the examination of other mesozoic forms still more desirable, and I determined, therefore, to study the question myself as best I could. My venerable friend, the Reverend P. B. Brodie, the pioneer student of British fossil insects, kindly came to my aid by sending me, from his unexampled collection of British mesozoic insects, such specimens as seemed to be cockroach wings. In this way, I have not only been able to study from the specimens themselves as many as ten of the wings which had before been described and figured, but nearly three times as many forms now published for the first time. The study of these naturally threw much light upon obscure points in the illustrations of species not studied from the specimens, both in England and on the continent,—a number less than those seen, and most of them easily interpreted with their aid and often without it. The fruits of that study are herewith presented, with my best thanks to the Rev. Mr. Brodie for his generosity. The number of mesozoic types now slightly exceeds the paleozoic, though their relative proportion to the rest of the synchronous insect fauna is far less than in the earlier period.

As in the paleozoic cockroaches, so here, most of the remains consist exclusively of front wings, and the principal guide to our knowledge of these early forms comes necessarily from a study of the neuration of these parts. This study, in the case of the paleozoic cockroaches, led to the discovery of some features of fundamental importance, by which the front wings of paleozoic cockroaches could be invariably distinguished from those of existing types. In paleozoic forms all of the main veins are completely independent, and the anal nervules fall at regular intervals upon the inner margin. In existing types, two or more of the main veins are amalgamated, either completely or to a large extent, while the nervules of the anal area strike the anal furrow, or at least compose a fusiform bunch directed toward the tip of the furrow. In consequence of these distinctions the paleozoic forms were distinguished as a separate group under the name Palaeoblattariae.

This discovery naturally led to the enquiry: Which of the veins in the modern tegmina have undergone the blending process? An examination of existing species showed that, as a rule, the veins were still independent in the hind wings, and an opportunity was therefore afforded of investigating the subject by the comparison of the front and hind wings of many modern types, and the conclusion reached that in modern tegmina the scapular and externomedian veins were those which had blended.[1]

This conclusion was shortly shown to be incorrect for mesozoic types, by the discovery, above mentioned, of cockroaches in the Triassic beds of Colorado, where a series of forms were found associated, some of them belonging to the Palaeoblattariae, and some with blended veins, allowing a more exact comparison than had before been possible. The conclusion newly reached from their study was that "when we compare the series of genera near the boundary line of the departure of the Palaeoblattariae toward later forms (those paleozoic cockroaches allied to Petrablattina) and especially those [Palaeoblattariae] brought to light by the discoveries at Fairplay, we find that in the mesozoic species at least, it is the mediastinal and not the externomedian vein which has blended with the scapular, although the externomedian also may become blended with the others in living types. This amalgamation has proceeded by the enlargement of the scapular area, which has crowded the mediastinal toward the base of the wing, whose few remaining branches finally become attached to the scapular vein, no trace of their former dependence remaining visible."[2]

The present study shows that this conclusion must also be modified by a somewhat further extension. The above statement is true of about two-thirds of the species, but there are also others, both in the Lias and the Oolite, in which a different or even a greater variation is found, the externomedian vein being sometimes united, throughout at least part of its length, with the scapular, or it may be wholly united with the internomedian, and in both cases, the mediastinal may or may not also be united with the scapular. The variation is therefore already very great in Liassic times, although it reached its maximum only in the later Oolite. With the exception then of about a dozen species of Palaeoblattariae in the Triassic rocks, all of the mesozoic cockroaches, like the living, have front wings in which two or more of the veins are coalesced.

As regards the other distinction, drawn from the anal area, there is much diversity,

[1] Mem. Bost. Soc. Nat. Hist. III, 28. [2] Amer. Journ. Sc. (3) XXVIII, 201.

and in fact very imperfect knowledge, this region being frequently missing in the fossils. In most of the genera the anal nervules, so far as known, strike the margin, but in some the species vary in this respect; in others their course is entirely unknown, while in such as are perfectly preserved in the most prolific genus, Mesoblattina Geinitz, they impinge indeed upon the margin, but show a decided tendency to direct themselves toward the tip of the anal furrow, as in many modern forms. This feature cannot therefore be said to have become fairly established in mesozoic times.

These changes in the general structure of the front wing are no doubt but one expression of the increasing heterogeneity in the neuration of the front and hind wing which was almost entirely unknown in paleozoic times, but which has reached a high development at the present day. The remains of the hind wings of mesozoic cockroaches are indeed not sufficiently abundant to prove this, but we have grouped here under one generic name, Aporoblattina, such single detached wings as seem to be properly considered as such, and here the veins are entirely distinct. Another indication of this specialization on the part of the front wing is their increasing density, by which the neuration is in part obscured. This is not very marked, but in some species is unmistakable.

A further peculiarity of mesozoic species, as a general rule, is their small size. In a previous paper, before the number of paleozoic forms known was as great as now, the average length of their front wings was estimated as 26 mm., and there is no reason to suppose that that measurement would be altered by later discoveries to any extent worth mentioning. On the other hand, even the Triassic Palaeoblattariae already show a tendency toward that diminution in size which is well marked in the mesozoic Blattariae, for the average length of the former is only 16 mm., while in the mesozoic Blattariae as a whole it is still further reduced to 12.5 mm. Even this would be somewhat diminished (to 11.5 mm.) if we should omit the species from the middle Oolitic beds of Solenhofen, all of which were large and some gigantic, one reaching a length of 60 mm. That this should be the case seems a little unexpected when we find the species of the upper Oolite (of England) a little smaller as a general rule than the Liassic forms. This somewhat curious fact led me to ask what should be considered the average size of the modern cockroach. I accordingly took Brunner's Systême des Blattaires and tabulated the measurements of the front wings given there whenever the material was at hand for the purpose, to the number of 243 species. One measurement only was taken for each species and where the sexes differed (as often excessively) these also were averaged. Of course the apterous species had to be omitted, and it was plain that the result would be too large as the larger species find their way to collections much more rapidly than the smaller forms. The general result was that the average size of the front wings of recent cockroaches is 18.2 mm. which is considerably more than that of the mesozoic species, and much less than that of the paleozoic forms.

As regards the relative geological position of these mesozoic cockroaches two facts are patent: 1°. No species has been found in more than one deposit. 2°. While all three of the genera of the Trias are peculiar to it (some of the genera of the Triassic Palaeoblattariae have also been found in lower paleozoic rocks) and two genera are found only in the upper Oolite, all of the genera found in the intermediate Lias also occur in the

Oolites. The genera peculiar to the upper Oolite are however very poor in species, one having only one and the other only two representatives, while the genera common to the Lias and Oolite are generally prolific in this respect.

Of the seventy-seven species of Blattariae mentioned in the following pages, not including those found in the Appendix, three are found in the Trias, seventeen in the Lias, three in the middle Oolite and forty-six in the upper Oolite, besides three whose precise horizon is unknown.

A comparison of the venation of the tegmina of mesozoic and recent cockroaches, to determine, as far as possible, the immediate relations of the former to existing forms, gives little satisfaction. Still, Mesoblattina and Rithma may be said to bear considerable resemblance to the Phyllodromidae—as Phyllodromia, Apolyta and Thyrsocera, for example—and the peculiar neuration of Elisama is in part repeated in the Panchloridae (*e. g.*, Panchlora, Leucophaea, Nauphoeta) and also occurs in some Phyllodromidae (Thyrsocera) and Epilampridae (Paratropa, Epilampra). Scutinoblattina also reminds one in certain features of some Epilampridae, like Phoraspis. The other genera, and particularly Blattidium and Pterinoblattina, appear to have no relations to any special type. As a whole, then, it would appear as if the *Blattariae spinosae* approached closer to the mesozoic forms than the *Blattariae muticae.*

As I have already stated, the most fundamental distinction separating the mesozoic from the paleozoic cockroaches is in the change which the principal nervures of the upper wings have undergone, by the basal or total amalgamation of some of them,—a change which reaches its culmination in living cockroaches.

On the basis of these differences, mesozoic cockroaches may be divided into three groups: *a*, those in which only the mediastinal and scapular veins are amalgamated; *b*, those in which the externomedian is united with one of the veins on either side of it; and *c*, those in which either the mediastinal, scapular and externomedian veins are all united: or there are two lines of union, one between the mediastinal and scapular, and the other between the externomedian and internomedian veins, *i.e.*, where, besides the union of the mediastinal and scapular veins, the externomedian also allies itself in whole or in part with the united mediastino-scapular, or with the internomedian. In all mesozoic cockroaches, excepting the Triassic Palaeoblattariae, amalgamation of some of the veins occurs; for a further study of Pterinoblattina convinces me that my first interpretation of its neuration was incorrect, in that what I had taken for the internomedian vein is really the anal, and that what was looked upon as the externomedian must be regarded as the united externomedian and internomedian veins.

a. The mediastinal and scapular veins of the upper wings, and these only, are amalgamated.

CTENOBLATTINA gen. nov. (κτενωτός).

In the wings of this group, which are minute, the humeral angle, usually considerably developed in cockroaches, is obliquely docked, and the united mediastinal and scapular veins occupy a broad area, at first nearly one-half of the breadth of the wing, and extend nearly to the tip, provided with numerous parallel more or less forking branches.

The internomedian occupies a very similar belt on the inner side, extending nearly or quite to the tip; and between them the pinched externomedian, enlarging a little toward the tip, finds narrow quarters. The anal area is very brief, but the character of its venation is not known.

Two of the species come from the English Purbecks; the third from the German Lias.

Ctenoblattina arcta sp. nov.

Pl. 20, figs. 1, 2.

This minute species, as may be seen by fig. 2, has its venation somewhat obscured, partially perhaps by the thickness of the integument. In its interpretation, in fig. 1, it is probable that the internomedian area is given too little width, as its apical nervules are given too little curvature. The form of fig. 2 is more correct. The wing is broadest at the extremity of the anal area, just before the end of the basal third; up to this point it increases rapidly in size, the humeral angle being strongly docked, and beyond tapers very gently to a well rounded tip. The costal area (as the united mediastinal and scapular areas may be termed) is crowded with nervules, every alternate one appearing a little heavier than the others, so that the intermediate are probably intercalary veins, as one would judge also from their absence from the internomedian area, where the veins are more distant. Excepting for the simple division in the middle of the basal half of the wing, the externomedian vein does not fork before the middle of the wing, and then but narrowly, but the whole of this region is obscure, though it seems certain that it occupies outwardly nearly the whole tip of the wing. The anal furrow is distinct and very strongly arcuate. The anal area is neither elevated nor depressed, the whole wing being entirely flat. The wing is about 2.7 times longer than broad, its length being 5.5 mm. and its greatest breadth a little more than 2 mm.

The specimen comes from the English Purbecks (precise locality not known), and occurs on a stone of a very pale sordid brown color, on which the veins appear dark brown; it was received from Rev. P. B. Brodie.

On account of the obscurity of the venation, and its apparent derivation from the thickness of the integument, I formerly, from partial study, considered this a species of Heer's genus Legnophora, from the Trias, and so referred it, without name, in Zittel's Handbuch der Paläontologie (II, 766); but a severer examination has enabled me to trace the neuration, which cannot be made to accord with that of Legnophora.

Ctenoblattina Langfeldti.

Blattina Langfeldti E. Gien., Zeitschr. deutsch. geol. Gesellsch., 1880, 521, Pl. 22, fig. 3; *ibid.*, 1884, 571.

This species seems certainly to fall here, but Geinitz appears to have confounded the costal and inner margins. The externomedian vein resembles the foregoing more than the following species, but first forks much farther from the base. The wing is 5.5 mm. long and about 2.2 mm. broad. It comes from the Lias of Dobbertin, Germany.

Ctenoblattina? pinna.

[Without name.] Brodie, Foss. Ins. Eng., 118, Pl. 5, fig. 5.
Blatta pinna Gieb., Ins. Vorw., 322.
Blattidium pinna Heer, Viertelj. naturf. Gesellsch. Zürich, 1864, 290.

This species appears to belong here, but I have not seen the specimen and the obscurity of the drawing renders its location uncertain. It is badly broken at base, so that the humeral angle and anal area are (probably) entirely obliterated. The fragment is represented as nearly 4.5 mm. long, and its real length was probably about 5 mm. It differs from the preceding species in the uniform width and greater extension of the costal area, which must reach the very tip of the wing, the apparent absence of spurious nervules in the same area, the even slenderer externomedian area hardly expanding apically, and the very great width of the internomedian area, which occupies fully half of the wing.

It comes from the English Purbecks.

Neorthroblattina Scudder.

Neorthroblattina Scudder, Proc. Acad. Nat. Sc. Philad., 1885, 108.

In this genus the wings are about two and a half times longer than broad, with fairly well rounded apices, the costal area extending nearly to the tip, and in the middle of the wing occupying nearly one-half its width. The internomedian vein is of varying importance, and in the large anal area the veinlets terminate on the margin; the anal furrow is strongly arcuate, and deeply impressed.

All the species come from the American Trias.

The four species are *N. albolineata*, *N. Lakesi*, *N. rotundata* and *N. attenuata*, all found at Fairplay, Colorado. They were briefly described in the Philadelphia Academy's Proceedings, and will be fully discussed and figured in a paper devoted to this Triassic locality, so that it is only necessary here to indicate their apparent position in the series.

Rithma Giebel (emend.).

Rithma Giebel, Ins. Vorw., 318; Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 113.

The wings of this group, as it is limited by me in the place above referred to, are generally rounded wedge-shaped, *i.e.*, slender and tapering (though the latter peculiarity is wanting in some even of the slenderest species) with the costal area large, occupying nearly or quite half of the wing, the main vein sinuous, generally conspicuously sinuous, rarely almost straight, terminating close to, sometimes even below, the tip. The anal area is generally pretty large, vaulted, and filled with arcuate parallel veins which terminate on the margin. The externomedian and internomedian veins are also sinuous and divide the remaining space about equally between them, each forking considerably and radiating apically. Their nervules, and especially those of the internomedian vein, are rarely more longitudinal than oblique. The genus stands midway between Neorthroblattina and Mesoblattina, the flatness of the humeral field, and the great extent of

the costal area distinguishing it from the former, the greater obliquity of the inferior nervules and particularly those of the internomedian area, as well as the parallel and similar course of the anal nervules, separating it from the latter.

Most of the species come from the English Purbecks, but two occur in the Lias of England and Switzerland.

Rithma Stricklandi.

Pl. 20, figs. 4, 5.

Blatta Stricklandi Brodie, Foss. Ins. Engl., 32, 118, Pl. 4, fig. 11 (2 figs.); Gieb., Ins. Vorw., 317.

Blattidium Stricklandi Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 290.

By the favor of Mr. Brodie, I have had the opportunity of studying and redrawing the original of this species, which shows a complicated cross-neuration by the overlapping of the four wings and the tenuity of the membrane. This has enabled me to trace out the separate neuration of the tegmina, as shown in fig. 4, which would not have been possible from the original drawing, which was in other respects not wholly correct. No description accompanied the figure.

The most perfect wing is the upper wing of the left side, and this is only preserved sufficiently to show that it probably belongs in this genus and cannot be identified with any other of the species here referred to Rithma. The humeral area is very narrow, and is not differentiated from the rest by its flatness; the costal area of nearly equal breadth until close to the tip as in the next species, but the main vein has a slight sinuosity and no terminal inferior forked vein, and its branches are comparatively few and distant. So too, are the branches of the externomedian, which in other respects do not differ from the next species. In the hind wing, the costal area is much narrower and distinctly tapers apically. The inner bases of all the wings are wholly obscured by the meso- and metathoracic scuta, which come to the surface as large spots, so that there is no indication even of the anal furrow; they indicate, however, the position of the bases of the wings, enabling us better to judge of their exact length, while the curves show where the tip must lie. Judging by these, the length of the wings was 12 mm.; the breadth of the two wings at rest 5.5 mm.; that of one of them, probably about 4 mm.; and the width of the mesothorax, 3 mm.

The specimen comes from the Purbecks of the Vale of Wardour, Wiltshire, England, and is of the same color as the dirty brown stone on which it rests, excepting that parts of the thorax are black, the veins varying from light to blackish brown. The surface of the specimen is very slightly convex, and the veins are slightly impressed.

Rithma Gossii sp. nov.

Pl. 20, fig. 15.

This species is founded on a nearly perfect wing in which only the anal area is missing. The wing is of nearly uniform width, nearly three times as long as broad, with a well rounded tip. It is of the same color, veins and all, as the dirty, chalky-white matrix;

the wing shows the upper surface and is arched transversely, the costal area roof-like, the veins running in slight furrows. It is peculiar for having, like *R. Stricklandi*, a very straight and uniform costal area, but the depressed humeral field is of the usual width, though rather short, the costal veins are numerous and crowded, and a supplementary inferior, forked, apical vein carries the area quite to the tip of the wing; the latter characteristic may well be individual. The externomedian and internomedian veins divide their space between them very equally with abundant, forked, almost perfectly straight veins, the internomedian area terminating just before the apical curve of the wing, and the externomedian first forking far before the middle of the wing. The anal furrow is no more depressed than the other veins, strongly arcuate in its basal half, straight beyond, with a slight outward curvature at the tip, which is opposite the first forking of the externomedian vein. The course of the main externomedian vein is almost exactly down the middle of the wing, and the nervules on either side of the wing are about equally crowded.

Length of wing, 6.5 mm.; breadth, 2.2 mm. The species is named for Mr. Herbert Goss, who has done so much in recent years to foster in England an interest in fossil insects. It comes from the English Purbecks and was submitted to me for study by the Rev. P. B. Brodie.

Rithma disjuncta sp. nov.

Pl. 20, fig. 14.

A single wing in which the characteristics of the neuration are well shown, although only fragments of the border appear. It is possible nevertheless to judge with probable accuracy of the form of the wing, which seems to have been pretty regularly obovate and a little more than two and one-half times longer than broad. The wing is perfectly flat on the dirty brown stone, with black veins and more or less broken black intercalary veins, especially in the costal area. The humeral field must have been very slight; the mediastino-scapular vein pretty strongly sinuous in the basal half, nearly straight apically, the costal area occupying in the middle nearly half the wing, terminating just above the apex, and being filled, including the intercalaries, with numerous, crowded, oblique, simple veins. The externomedian vein follows the same sinuous course, is forked not far before the middle of the wing, the lower branch again forked at less than half-way to the margin; probably all fork again beyond, but the specimen is broken here. The internomedian reaches just about as far out as in *R. Gossii*, is doubly arcuate, and has three or four inferior, straight, parallel, oblique branches. The nervules of the inner are not nearly so crowded as those of the costal margin. The anal furrow is not depressed, strongly arcuate at base, straight and oblique beyond, reaching the margin opposite the first forking of the externomedian vein.

Probable length of wing, 5.3 mm.; breadth, 2 mm. The species is the smallest of the genus, comes from the Wiltshire Purbecks, and is in the collection of the Rev. P. B. Brodie.

Rithma liasina.

Pl. 20, fig. 7.

[Without name] Brodie, Foss. Ins. Engl., 101, Pl. 8, fig. 12.
Blattina liasina Gieb., Ins. Vorw., 317.
Blattidium liasinum Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 289.
Rithma liasina Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 114.

By the kindness of Rev. Mr. Brodie, I have had the opportunity of studying the original specimen shown in Pl. 8, fig. 12, of his work, and find that it differs so much from the figure given that a new drawing is necessary, which shows better than the original that it belongs in Rithma. The wing exhibits an under surface on a dirty light brown stone, on which the veins show slightly darker; it is very slightly concave, the interspaces being slightly depressed in general, and rather markedly depressed where figured in white. The wing is largest just before the middle, tapers regularly beyond, and probably had a well rounded tapering tip, but the apex is much broken. The costal margin is gently arcuate and the inner margin straight. The humeral field is very large, broad and extends to the middle of the wing, is flat, and does not partake of the concavity of the rest. The mediastino-scapular vein is rather strongly sinuous and terminates just above the tip of the wing, the broadest part of the costal area being in the middle where it occupies nearly half the wing. The veins of this area are tolerably numerous, longitudinally oblique, parallel, the basal ones simple, the apical forked. The externomedian vein and its branches are disposed almost exactly as in *R. disjuncta*, but occupy a little less space on the margin, being more displaced by the internomedian veins, which from base apically change their course conspicuously, the basal branches being almost transversely oblique with a slight terminal curve outward, the outer arcuate at root and nearly longitudinal beyond; the branches on the costal and inner margins have a similar distance apart. The anal area is very large, the furrow being roundly bent in the middle and transversely oblique beyond, but yet reaching nearly or quite half-way down the inner margin and opposite the basal forking of the externomedian vein; it is not prominent, and would appear to have been no more strongly depressed (on upper surface) than the other veins.

Length of fragment, 12 mm.; probable length of wing, 14.5 mm.; breadth of same, 5.25 mm. The specimen comes from the Lias of Wainlode, Strensham, England.

Rithma formosa.

Blattina formosa Heer, Lias-Ins. Aarg., 15, Pl., figs. 41, 42; Id., Urw. Schweiz, 83, Pl. 7, figs. 1, 1*b*.
Rithma formosa Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 114.

In this species, in which the typical rounded wedge-shaped form of the wing is excellently shown, and only interfered with by the lateral expansion of the anal area, perhaps due to displacement by the crushing of its vaulted form, the humeral field is very narrow and small, the costal area broad, equal and appearing to embrace the tip (the figures are

not quite clear nor consistent), while in no other species is the fan-like disposition of the rays of the externo- and internomedian veins so well shown as here; they divide the field very equally between them, the externomedian vein forking far back toward the base; and the large anal area with its almost regularly arcuate anal furrow and parallel veins occupies about a third of the inner margin. The nervules on the two sides of the wing are of similar distance apart and rather crowded. I have not seen specimens of this species but describe it briefly from the figures.

The length of the wing is 15.5 mm; its breadth 5.5 mm; it comes from the Lias of Schambelen in Switzerland, and is known from a single wing.

Rithma Morrisi.

[Without name] Westw., Quart. Journ. Geol. Soc. Lond., x, 390, Pl. 18, fig. 34.
Rithma Morrisi Gieb., Ins. Vorw. 319; Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 113, 114.
Blattidium Morrisi Heer, Viertelj. naturf. Gesellsch. Zürich, ix, 290.

A single nearly perfect wing, known to me only by Westwood's figure, is closely related to *R. formosa*, but is smaller, has its greatest width close to the base, has even more crowded veins, with more abundant dichotomizing and a much smaller not protruding anal area. The humeral field is very small but not slender, the costal area as in *R. formosa*, but terminating just above and not mbracing the tip, the median veins much as there but with more abundant forking of the branches. The anal furrow appears to be bent roundly in the middle and to be oblique apically, yet not to reach even a fourth way down the inner margin.

The length of the wing is 10 mm. and its breadth nearly 4 mm. The specimen comes from the Lower Purbecks of Durdlestone Bay, England.

Rithma purbeccensis.

[Without name] Westw., Quart. Journ. Geol. Soc. Lond., x, 390, Pl. 18, fig. 32.
Rithma purbeccensis Gieb., Ins. Vorw., 319; Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 113, 114.
Blattidium purbeccensis Heer, Viertelj. naturf. Gesellsch. Zürich, ix, 290.

This wing is only known to me as the last, and it is less perfect, but has characteristics which easily distinguish it. It is probably broadest in the middle of the basal half and has the typical wedge shape. The humeral field is large and broad, tapering much apically and reaching more than one-third way down the costal margin. The mediastino-scapular vein is very sinuous, making the costal area broadest in the middle of the apical half of the wing where it occupies two-thirds of the entire breadth, but as the vein curves upward again apically and probably strikes the exact tip of the wing, it narrows rapidly at the end; the area is filled with crowded, sinuous or arcuate, partially forked nervules, which are much more crowded than the distant, slightly forked, sinuous branches of the externomedian and internomedian veins, which appear to divide the space to the anal furrow about equally between them. The anal furrow is strongly arcuate in

the middle and terminates as far out as the humeral field and far beyond the basal branching of the externomedian vein; anal veins not preserved.

The length of the fragment is 10.5 mm. and the presumed length of the wing 11.3 mm.; its breadth is 3.5 mm. It comes from the Lower Purbecks of Durdlestone Bay, England.

Rithma Daltoni sp. nov.

Pl. 20, fig. 16.

The single wing sent to me by Mr. Brodie is preserved in a similar manner as *R. purbeccensis* and was at first taken to be the type of that species, but a closer examination showed that if the latter has been correctly drawn by Westwood, this must be distinct from it. The wing is of the same color as the dirty chalky white stone on which it rests, the veins even showing no color distinction. These are finely impressed, showing as well as the slightly arched surface that its upper side is seen; there are some faint intercalary veins in the costal area not shown in the figure; the anal furrow is no more deeply incised than are the others, and the humeral field is flat and at a lower level than the rest. The wing is undoubtedly broadest in the middle of the basal half, is wedge-shaped, tapering very regularly and considerably, with a straight inner and gently convex costal margin, to a somewhat pointed (here broken) tip. The humeral field, at first equal, tapers in the apical half, which reaches nearly to the middle of the wing. The mediastino-scapular vein is broadly sinuous, giving the costal area the same shape that it has in *R. purbeccensis*, including the entire tip of the wing, the extremity of the vein passing a short distance below the very apex; its branches are nearly straight, parallel and oblique, the early ones simple, the later, arising in the broadening field, forked, the forks originating on a line with the bases of the simple veins. The remainder of the wing is as in *R. purbeccensis*, only the branches are equally distant on the two sides of the wing.

Length of the fragment 10.75 mm.; probable length of wing 12 mm.; its breadth probably 4 mm., though the extreme breadth at the tip of the anal furrow is slightly less, or 3.85 mm. The specimen comes from the English Purbecks, and the species is named for Mr. W. H. Dalton of the Geological Survey of Great Britain.

Rithma Westwoodi.

Pl. 20, fig. 11.

[Without name] Westw., Quart. Journ. Geol. Soc. Lond., x, 390, 396, Pl. 18, fig. 22.
Rithma Westwoodi Gieb., Ins. Vorw., 318–319.
Blattidium Westwoodi Heer, Viertelj. naturf. Gesellsch. Zürich, ix, 290.

Among the specimens sent me by Rev. P. B. Brodie, one occurs which seems to be the type of Westwood's figure, since in all that I have seen the figure is reversed, and in this instance the resemblance is close. I am able, therefore, to describe this species from the original and find the doubts I expressed concerning its position (Proc. Acad. Nat. Sc. Philad., 1885, 113) hardly to be confirmed, though of all the species of Rithma it is the most closely related to Mesoblattina.

The under surface is exposed, the specimen being transversely concave, with elevated veins and concave interspaces: all are of the same color as the dirty chalky-white stone.

The wing is exceedingly slender and subcuneiform, being nearly four times longer than broad, its greatest breadth just before the middle, both costal and inner margins gently arcuate, and the tip somewhat produced. The outer half of the inner margin appears to be slightly broken, but is apparently narrowed to the very slightest degree. The humeral field is large, flat, rather regularly cuneiform, reaching about two-fifths way down the costal margin, separated by a ridge (furrow, if it were viewed from above) from the adjacent parts. The mediastino-scapular vein is strongly sinuous and terminates far below the tip of the wing, so that the costal area, which in the entire apical half of the wing occupies more and generally much more than half the breadth, embraces the entire tip and is filled with regular, straight or gently arcuate, simple or forked, parallel, not crowded branches. The externomedian and internomedian areas divide equally between them what little space is left between this broad costal area and the anal furrow. The anal area is large, the furrow, which is no more prominent than the other veins, being bent roundly and sharply in the middle, and yet reaching almost as far as the humeral field, and as far as the basal fork of the externomedian vein. No anal veins are preserved. The externomedian branches are only three or four in number, sinuous and longitudinal; those of the internomedian quite as few, nearly straight and oblique.

The length of the wing is 10 mm.; its breadth, 2.6 mm. It comes from the English Purbecks, and according to Westwood, from the lower members at Durdlestone Bay.

It is possible that the obscure specimen figured in Pl. 20, fig. 6, also belongs to this species. It is too imperfect to determine. The slenderness of the wing and the resemblance of the humeral field and anal furrow are very similar, but the form is less tapering, and the nervules, especially toward the tip, are much more crowded and more directly longitudinal. It is possible, however, that it should be represented as broader, as the inner edge comes against a slight elevation in the dirty chalky-white stone. Perhaps a closely allied species is indicated. It comes from the English Purbecks and was submitted to me with the other by Mr. Brodie.

Another species, apparently belonging to this genus, is indicated by the obscure specimen figured in Pl. 20, fig. 8. It differs from any in the decided tapering of the apical half to an almost pointed tip, but the neuration is too imperfect to indicate any further characters. Probably the right hand margin is the costal. The wing is flecked with reddish-brown, contrasting with the light brown color of the stone, the veins dusky. Its length is 7.25 mm., and its breadth, 2.6 mm.; and like the last it comes from the English Purbecks and was communicated by Rev. Mr. Brodie.

Rithma? minima sp. nov.

Pl. 22, figs. 2, 8*a*, 8*g*, 11.

[Without name] figured with others by Westwood, Quart. Journ. Geol. Soc. Lond., x, 383–384, Pl. 15, fig. 14, the uppermost and the left hand of the two lowest objects.

Two objects which probably belong together, as their relative sizes agree perfectly, are found on the same light brown stone, and are referred here from slight indications

only in the character of the wing. The species is certainly distinct from any known on account of its size alone, and the direction of the mediastino-scapular vein is such as to lead one to presume it terminated at the very tip of the wing, which is of an oval shape and rather broad for its length, tapering in the apical half to a rounded tip equally sloping on both sides. The anal furrow is not very strongly arcuate, but unusually transverse and the anal veins impinge on the margin. An upper surface is shown which is slightly domed. Length, 4 mm.; breadth, 1.9 mm.

The other object is a pronotum of a cockroach, 3.25 mm. broad and 2.3 mm. long, broadly and transversely oval, the hinder margin less rounded than the front margin, the disc slightly convex, with slight irregularities like gentle longitudinal plications, as seen in the figure (fig. 2), the delicate edge very slightly marked by a darker line. As it corresponds exactly to what we should expect of a pronotum belonging with the wing on the same stone, and is only about 2 cm. removed from it, and as no other known mesozoic species approaches it closely in size, there can be little doubt that they belong together. The specimens come from the middle Purbecks of Dorset, England.

The other objects found on this same stone are also figured on the same plate. One of them, *Pterinoblattina pluma*, is described elsewhere in this paper. Fig. 4 (8*b*) is fig. 14‡ of Westwood and considered by him as the wing of a grasshopper. Fig. 10 (8*f*) is fig. 14⊙ of Westwood and considered by him as one of the Trichoptera. Fig. 12 (8*d*) is fig. 14* of Westwood, also considered by him as trichopterous. Fig. 13 (8*e*) is fig. 14** of Westwood and named by him *Cercopidium Telesphorus*. These will be discussed at some future time, and are only mentioned here to explain the plate, according to Westwood's views.

Mesoblattina E. Geinitz.

Mesoblattina E. Gein., Zeitschr. deutsch. geol. Gesellsch., 1880, 519–520; Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 114.

This genus, proposed at first by Geinitz as a sub-genus for a couple of species of mesozoic cockroaches, on account of the course of the anal nervures, was afterwards extended by him to include another species, which disagreed in this particular from the others. In this he was right, inasmuch as the group, which should be accorded generic value, contains forms which vary considerably in this respect. The characters referred to in my paper on mesozoic cockroaches (see above) relating to the course of the internomedian and externomedian nervules seem to be more important. The genus was the most prolific of any in mesozoic times. The wings are generally slender and parallel sided or nearly so, though in not a few they taper as conspicuously as in most of the species of Rithma, and one species at least is broadly oval. The flat humeral field is nearly always large and conspicuous, and the costal area large as in Rithma, from which it is distinguished mainly by its greatest peculiarity, which is the basal sinuosity and subsequent almost completely longitudinal course of the externomedian and internomedian veins and all their branches, the latter even rarely touching the border before the apical half, and generally not before the apical fourth or fifth of the wing, while the anal furrow does not extend out after them, but meets the border at a broad angle. In addition to this, the veins of the anal area show in a considerable number of species (in

many this part is not preserved) a strong tendency to run in a similarly longitudinal course, so that they trend from different parts of the area toward the outer lower extremity of the area, where they are closely clustered. This is an approach toward the generally longitudinal course of the anal veins in recent cockroaches, where they abut upon the anal furrow and not on the margin. The genus stands midway between Rithma and Elisama, the latter being a genus in which the peculiar course of the median veins is more conspicuous than here, but which has no such large anal area as is common to the species of this genus. Mesoblattina is far more abundant in species than any other mesozoic genus, being found in considerable abundance both in the Lias and in the Oölite, but especially in the latter. The species may be separated into two groups.

1. *The anal veins are parallel and end on the margin at equal distances apart.*

Mesoblattina Blakei sp. n. v.

Pl. 20, fig. 12.

A single wing from which a considerable portion of the tip is lost, but which shows all the characteristic parts of the neuration almost completely. As restored on the plate, the wing is exceedingly slender, nearly four times as long as broad, with very parallel sides, the costal border gently arcuate, flattened in the middle and the inner margin nearly straight. The humeral field is very long, lanceet-shaped, extending nearly to the middle of the wing. The mediastino-scapular vein is exceedingly sinuous, the area being broadest opposite the tip of the humeral field, where it is nearly half of the breadth of the wing, and extending (probably) only a little distance beyond the middle of the outer half of the wing; the nervules are oblique, simple, parallel, tolerably abundant. The externomedian vein first forks somewhat before the middle of the wing and has long, so far as can be seen simple, wholly longitudinal, or upward curving branches which trend so as probably to terminate on the tapering apex of the wing wholly above the middle line; probably they fork near the tip. The internomedian vein is divided back of the first forking of the externomedian into two branches, the upper of which forks near the middle of the wing and resembles one of the externomedian offshoots; the other has three or four inferior, sinuous, very longitudinal branches, all impinging on the outer half of the lower margin and rather more closely crowded than the costal nervules. The anal area is very large, extending very nearly as far out as the humeral field; the anal furrow is depressed, very uniformly arcuate, and the anal veins are very peculiar, appearing to consist of a mid-vein parallel to the anal furrow, dividing the area into two nearly equal halves and furnished with longitudinally oblique parallel nervules which appear to terminate at equidistant points on the margin; and second, of a single slight vein midway between the first and the anal furrow, the termination of which is uncertain since the outer lower half of the anal area is broken away, revealing beneath the very closely approximated, parallel, oblique offshoots of (probably) the anal area of the hind wing.

Length of fragment 15 mm.; probable length of wing 19 mm.; width 5 mm. In the structure of the anal area this wing is totally different from any other species. It comes from the Upper Lias of Alderton, Gloucestershire, England, and was sent me by Rev.

P. B. Brodie. It rests on a dirty brown stone, the veins being blackish. I have named it for Rev. J. F. Blake who has made some researches upon the Lias insects.

Next to this I place, doubtfully, a couple of forms which are evidently nearly related, and apparently belong in this vicinity, but are too imperfect to discuss fully until better material shall offer.

One of them (Pl. 20, fig. 3) has a large and long costal area in which the main vein is regularly arcuate and its oblique branches are distant at base and apically forked; an externomedian vein of little importance with two or three wholly longitudinal branches running down the middle of the wing; an internomedian with three or four inferior, at first rather distant, bent branches, terminating far out; and an anal furrow which is oblique and straight apically, indicating a rather large anal area.

It should be noted however that the internomedian area is entirely separated from and lies at a slightly lower level than the rest of the wing, so that it is not impossible (though not probable) that there are two wings here. Both parts are perfectly flat with brownish veins.

The length of the fragment is 5.75 mm. and its breadth 4.5 mm. indicating a wing about 12 mm. long, and perhaps 5 mm. broad. It comes from the English Purbecks and was sent me by Rev. P. B. Brodie. On the same stone, close beside the upper fragment, lies the specimen of *Diplaroblattina Bailyi* described further on and figured on Pl. 22, fig. 5.

The other (Pl. 20, fig. 13) has a broad costal area which would be rather short, but that the otherwise rather strongly arcuate main vein is reinforced apically by two or three superior longitudinal branches, while the inferior branches are numerous, simple, parallel and oblique; the externomedian vein is much as in the preceding and the internomedian has almost equally longitudinal veins, forking considerably and gently arcuate at base indicating a long anal area. The slight depression of the veins indicates an upper surface, but the surface itself is perfectly flat. There is a slight ferruginous tinge to the wing which with the blackish brown veins distinguish it quickly from the dirty light brown stone. The length of the fragment is 9 mm. and its breadth 4.25 mm., indicating a wing about 13 mm. long and perhaps 4.5 mm. broad. It was received from Rev. Mr. Brodie but without indication of locality or horizon.

Mesoblattina Bensoni sp. nov.

Pl. 20, fig. 17.

An almost perfect wing, being broken slightly at the base. It is very slender, being almost four times as long as broad and of the same shape as *M. Blakei* is presumed to be. An under surface is shown. The humeral field is moderate, extending over somewhat more than a quarter of the wing. The mediastino-scapular vein is gently sinuous near the base, beyond nearly straight, terminating just above the extreme apex and giving the costal area nearly half the wing; the veins are numerous, slightly elevated, parallel, longitudinally oblique, and in the outer half of the wing always forked to a moderate degree. The externomedian first forks opposite the end of the humeral field, and has ul-

timately about eight or nine branches which have a very graceful longitudinal course, scarcely arcuate downward and occupying the whole of the lower half of the wing tip. The internomedian is first forked even earlier than the preceding, and its similarly abundant and crowded branches have a very graceful and gentle, longitudinally sinuous sweep, all falling on the margin in the apical two-fifths of the wing. The anal area is ample, the furrow being very regularly arcuate, terminating near the end of the second fifth of the wing, depressed, especially in the apical half; the anal nervules of a similar abundance to those of the rest of the wing, mostly forked near their base, arcuate and parallel to the furrows.

The length of the wing is about 18.25 mm. its breadth 5.1 mm. It comes from the Upper Lias of Dumbleton, Gloucestershire, England, where it was obtained by Rev. R. L. Benson, who gave it to Rev. P. B. Brodie, to whom I am indebted for an opportunity to study it. It is of a dull fuliginous color with here and there a reddish tinge on a bluish gray stone.

Mesoblattina Swintoni sp. nov.

Pl. 20, fig. 10.

A fragment of the most important parts of a wing shows so great a resemblance to *M. Bensoni* that it can hardly be doubted that it belongs in this immediate vicinity, while its differences will scarcely allow us to place it in the same species. The general distribution of the branches of all but the anal veins (which are not preserved) is essentially that of *M. Bensoni*, even to the relative origin of the earliest forks of the externo- and internomedian veins and their relation to the humeral field; but the course of the mediastino-scapular vein (which is quite straight just where in *M. Bensoni* it is most sinuous, and gives the costal area about two-fifths of the area of the wing), and the less strongly arcuate and apically more straight anal furrow, which gives the area a greater longitudinal extent while the straightness of the superior veins lessens its breadth, give it at once a different aspect from *M. Bensoni* and renders it most probably an entirely distinct species. It is also probable that it is not so slender a species as the preceding, being probably but little more than three times as long as broad.

The fragment is 8 mm. long, and 5 mm. broad, but the probable length of the wing was about 18 mm. and its probable breadth 5.5 mm. It comes from the English Purbecks and is in the collection of Rev. P. B. Brodie. The species is dedicated to Mr. A. H. Swinton who has contributed somewhat to our knowledge of English fossil insects. It occurs on a dirty chalky-white stone, and is faintly fuliginous in color. An upper surface is shown and the wing is faintly arched transversely but is otherwise flat; the veins are channelled, the anal furrow and internomedian less than the others, but the anal furrow is not depressed below the level of the other veins.

Mesoblattina Geikiei sp. nov.

Pl. 20, fig. 9.

A nearly perfect wing, beautifully preserved, showing an upper surface. It is slender, being slightly more than three times as long as broad. The humeral field is moderate

being about as long as the width of the wing, and lancet-shaped. The mediastino-scapular vein is gently and broadly sinuous terminating a little above the very apex of the wing, making the costal area broadest in the middle and a little less than two-fifths the width of the wing; its branches are tolerably numerous, longitudinally oblique, the basal ones simple, the others which are more oblique forked about their middle. The externomedian vein forks first opposite the tip of the anal furrow, and terminates as far below the tip as the upper vein above it; it has two or three simple or forked longitudinal branches. The internomedian forks opposite the end of the humeral field and has three or four more or less longitudinally sinuous branches impinging on the outer half of the inner margin, which, like the costal branches, are less crowded on the margin than the externomedian. The anal furrow is rather deeply depressed, strongly and very regularly arcuate, terminating a little beyond the end of the basal third of the wing; the anal nervules are parallel to it, but sinuous mesially (as if by an accident of inhumation) and apically forked, terminating at equidistant points on the margin; they are about as distant as the costal branches. The whole wing, excepting in the basal half of the costal area and of course the humeral field, shows a cross venation between the nervules, breaking them into pretty regular quadrate cells.

The length of the specimen is 12.25 mm.; probable length of wing 13.5 mm.; its breadth 4.5 mm. It comes from the Lias of Brown's wood, Moreton Bagot, Warwickshire, England, and was sent me by Rev. P. B. Brodie. It is named for the present director of the Geological Survey of Great Britain. The wing, which glistens a little, is scarcely darker than the slate-gray stone on which it rests; the veins, which run in depressions (while the intercalaries keep the ridges of the roof-like interspaces) are reddish brown, interrupted frequently by obscurer portions giving them a flecked appearance under the lens; the same is true of the cross veins in the anal area.

Mesoblattina dobbertinensis.

Blattina (*Mesoblattina*) *dobbertinensis* E. Gein., Zeitschr. Deutsch. geol. Gesellsch., 1884, 570, Pl. 13, fig. 1.

Mesoblattina dobbertinensis Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 115.

This species has been described with some care by Geinitz, and needs no further mention than to say that its nearest ally appears to be *M. Geikiei*, a species twice as long; it differs from it also in the greater brevity of the anal area and the much greater breadth and importance of the costal area.

Its length is 6.5 mm. and it comes from the Lias of Dobbertin, Germany.

2. *The anal veins are directed toward the tip of the anal furrow.*

Mesoblattina Higginsii sp. nov.

Pl. 21, fig. 14.

This species and the next, of neither of which is the anal area known, are placed in this group because of their general relations to the species which unquestionably fall here, though it may readily be found hereafter that they must be transferred to the

preceding group, to the latter species of which they bear many marks of resemblance, but from which they also both differ much in the immense extent of the humeral field.

A single wing with a fragmentary tip represents the upper surface of this species. It is of a dull, pale yellow color on a dirty chalky-white stone. The surface is flat, the veins depressed and slightly dusky. Restoring the form of the apex from the course of the existing margins and veins, the wing appears to have been elongate elliptical in shape, probably three times as long as broad, with uniformly and considerably arcuate costal margin. The humeral field is depressed, lancet-shaped, and of unusual extent, reaching certainly over one-half the wing and probably more. The mediastino-scapular vein is pretty strongly sinuous, especially arcuate a little beyond the base and terminates at the tip of the wing, the costal area occupying in the outer half of the wing fully half its breadth; the branches are longitudinally oblique, straight, parallel and not crowded, the basal ones simple, the outer forked and more longitudinal. The externomedian is closely attached to the preceding vein in the basal third of the wing, beyond that arcuate with superior, forked, longitudinal branches, the first fork opposite the end of the anal furrow. The internomedian is pretty strongly sinuous and obliquely longitudinal with three or four inferior, rather distant, arcuate branches, strongly arcuate and sublongitudinal as they approach the margin, which they touch only in the outer half of the wing; it first forks opposite the divergence of the upper veins. The anal area is very large, the furrow no more impressed than the other veins, strongly and pretty regularly arcuate, terminating, by reason of a slight outward sweep at the tip, not far short of the middle of the wing. The ultimate branches are more crowded on the apical than on the costal or inner margins.

Length of fragment, 11 mm., probable length of wing, 15.5 mm., breadth, 5.4 mm. The specimen comes from the English Purbecks, locality not stated, and was submitted to me by Rev. P. B. Brodie. The species is named for Rev. H. H. Higgins of Liverpool.

Mesoblattina Murchisoni.

Pl. 21, fig. 5.

[Without name] Westw., Quart. Journ. Geol. Soc. Lond., x, Pl. 18, fig. 43.
Rithma Murchisoni Gieb., Ins. Vorw., 319.
Blattidium Murchisoni Heer, Viertelj. naturf. Gesellsch. Zürich, ix, 290.
Mesoblattina Murchisoni Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 114-115.

Among the species with which I have been favored by Mr. Brodie is the type of Westwood's figure, and as this is defective in some particulars, I have drawn the specimen again. It is in much the same state of preservation as the preceding and though nearly related to it is nevertheless very distinct in the sweep of the inferior veins. It shows an under surface, nearly flat, the humeral field being a very little higher than the rest, the veins seated on slightly convex ridges. The specimen is of the same color as the dirty, chalky-white stone. Apparently no part of the inner margin is present, but the course of the inferior branches leads us to presume that it is straight, and the restoration of the wing on this basis, with the regularly arcuate curve of the costal, leads us to presume it

was a little more than three times as long as broad, and, while nearly equal in width throughout, broadest in the middle. The humeral field is large, lancet-shaped but broadest shortly before its pointed tip, reaching just about to the middle of the wing. The mediastino-scapular vein is pretty strongly sinuous and especially arcuate a little beyond the base, exactly as in *M. Higginsii*, curving upwards apically and terminating before and above the tip, making the costal area broadest in the middle, where it is a little less than half the width of the wing; the nervules are exactly as in *M. Higginsii* or perhaps a little more oblique. The entire structure of the externomedian is a repetition of what is found in the last species, excepting that the basal divergence from the upper veins is a trifle earlier, and that all the nervules impinge on the apical border above, instead of all below the tip. The internomedian veins are more numerous and crowded than in *M. Higginsii*, have a more decided basal curve, and so throughout nearly their entire length are almost completely longitudinal, sub-parallel to the mediastino-scapular vein, and undoubtedly parallel to the inner margin. The anal area is tolerably large, but not so large as in the last species; the furrow, which has the character of the other veins, is strongly arcuate in the basal half, bent beyond the middle, and transversely oblique and straight beyond, terminating probably at about the end of the basal third of the wing. As stated, the anal veins are absent, and it is only presumed to belong in this section by its affinities to others and especially to *M. Bucklandi*.

Length of fragment, 11.5 mm.; probable length of wing, 13 mm.; breadth, 3.85 mm. The specimen studied is the original of Westwood's figure and comes from the Lower Purbecks of Durdlestone Bay.

Mesoblattina Bucklandi sp. nov.

Pl. 21, fig. 2.

Although a slight fragment is broken from the base and from the apex of the specimen representing this species, it is practically perfect, and though the costal margin is considerably less arcuate, it is of much the same shape as that presumed of *M. Murchisoni*, with which it agrees closely in all other particulars. It shows an under surface, being concave, the anal area separately and to a considerable degree; the veins run along the top of convex ridges. The humeral field is, however, simple, lancet-shaped, and only about two-fifths the length of the wing, though still extending further than the anal area. The costal area is almost a complete duplicate of that of *M. Murchisoni*, but is a little broader in the middle, almost equalling half the breadth of the wing. The externomedian vein arises in the same way but first forks a little later, just beyond the tip of the anal area, and the branches, diverging very slightly and uniformly, cover a considerable space on the margin, so as to occupy nearly all the arcuate portion of the apex below the costal area. The internomedian veins are hence a very little less longitudinal, trending slightly downward, though they strike the margin only in the apical half of the wing. The anal area is of about the same size, but the furrow, which if an upper surface were shown would be uniformly and rather deeply impressed, is almost uniformly arcuate, with no median bend, striking the margin obliquely, a little beyond the basal third of the wing. The anal veins, next the furrow subparallel to it, form as a

whole a subfusiform bundle, its outer apex directed toward the extremity of the anal furrow; they seem, however, to terminate rather on the innermost vein which runs parallel to the margin, than on the margin itself. The anal area and the outer adjoining parts show a fine cross-veining breaking up the interspaces into tolerably regular quadrate cells.

Length of fragment, 10 mm.; presumable length of wing, 11 mm.; its breadth, 3.25 mm. The specimen, received through the favor of Mr. Brodie, comes from England, but its location and horizon are not indicated. It is probably from the Purbecks, and is named in memory of William Buckland. The wing is of the same color as the dull bluish gray matrix, but the veins, generally scarcely darker, are in places quite black.

Mesoblattina elongata.

[Without name] Westw., Quart. Journ. Geol. Soc. Lond., x, 394, Pl. 15, fig. 23.
Blattina elongata Gieb., Ins. Vorw., 322.
Mesoblattina elongata Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 115.

This species is too obscurely figured to enable me to describe its structure in detail, but it certainly agrees closely with *M. Bucklandi*, with which it agrees well also in size. As, however, they differ in several points of importance, I have not thought it right to consider them identical; in particular may be noted in this species the comparative brevity of the humeral field, which appears to be broken off, the abundance of the costal nervures, and the upward sweep of the median nervules.

The species is represented as 11.75 mm. long, and comes from the Middle Purbecks of Durdlestone Bay, England.

Mesoblattina protypa.

Blattina (*Mesoblattina*) *protypa* E. Gein., Zeitschr. Deutsch. geol. Gesellsch., 1880, 519–20, Pl. 22, fig. 1; Id., *ibid.* 1884, 569–70.
Mesoblattina protypa Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 114.

This species, distinguishable among its neighbors by the comparative brevity of the humeral field, the narrowness of the costal area and the straightness of the mediastino-scapular vein, has been carefully described and figured by Geinitz, and needs no further mention here.

The wing is 8.5 mm. long and comes from the Lias of Dobbertin, Germany.

Mesoblattina Murrayi sp. nov.

Pl. 21, fig. 4.

This species, known by a single example broken in the middle and lacking the tip, is still so nearly complete as to be satisfactory, and its evident relationship to the next two species shows that, although the anal veins are wanting, it must fall in this group. The specimen is scarcely dingier than the dirty chalky-white stone on which it lies, the veins concolorous. The upper surface is exposed and it is well arched, the veins impressed, the interspaces convex, and when narrow, as at apex, prominent. The wing is broadest a little before the middle, and tapers very gently owing to the arcuation of the

costal margin; the tip is probably pretty fully rounded. The humeral field is well developed, well marked, flat and strongly depressed, slenderly lanceolate, extending over the basal two-fifths of the wing, the costal border delicately marginate. The mediastino-scapular vein has an entirely similar course to that of *M. Murchisoni*, making the costal area broadest in the middle of the wing, but there only two-fifths the width of the wing; the nervules are simple, rather longitudinally oblique, parallel and numerous. The base of the externomedian vein is obscured, but the branches, which are occasionally forked in the apical half of the wing, are all straight, crowded and completely longitudinal or trend slightly upward, occupying on the margin the greater, especially the upper, part of the tip. The internomedian vein first forks before the middle of the basal half of the wing, is very sinuous, the basal branches strongly bent near the outer angle of the anal area and afterwards sweeping outward with a slight obliquity. The anal furrow is not depressed, strongly arcuate, its tip slightly sinuous, reaching a little beyond the basal third of the wing.

Length of fragment, 13.65 mm.; probable length of wing, 16 mm.; its breadth, 5.35 mm. The specimen, the study of which I owe to Mr. Brodie, comes from the English Purbecks, locality not stated, and is named for the late Andrew Murray, Esq., who found time amid other valuable studies to describe the only known fossil insects of British India.

Mesoblattina Brodiei sp. nov.

Pl. 21, fig. 7.

The species is represented by an excellent specimen showing the upper surface of the wing, a little dingier than the dirty chalky-white stone on which it lies; it is slightly convex with the flat humeral field declivent, its inner border deeply impressed like the anal furrow; all the veins are impressed and of the color of the wing, those of the externomedian and internomedian areas much more faintly than the others. The wing is obovate in general form, but is of somewhat irregular shape, in which it agrees in part at least with *M. Mantelli*. The costal margin is strongly arcuate up to the tip of the humeral field, and beyond that straight to the very broadly rounded apex of the wing. The inner margin has two pretty strong and independent curves; one that of the anal area, and the other that of the remainder of the wing, where, while the curve is uniform, the effect is gained of being subparallel to the costal margin until half way to the tip, when the wing tapers somewhat by the rounded excision of the lower outer angle. The wing as a whole is about two and one-half times as long as broad. The humeral field is lanceolate, its inner border bent in the middle, its pointed tip reaching two-fifths way down the wing. The mediastino-scapular vein, parting from the humeral field at its angle, runs subparallel to, but a little divergent from, the costal margin in a very broadly arcuate curve to the tip, throwing off many parallel, oblique nervures, the basal ones of which are simple and crowded, the apical more distant, more longitudinal and forked, forming a costal area which occupies considerably more than two-fifths of the width of the wing. The externomedian vein runs close and parallel to the preceding, first forks just before the tip of the humeral field, and has three or four generally simple, inferior, sweeping, arcuate, longitudinal branches, followed by the even more arcuate, simple, api-

cally longitudinal, internomedian branches, which arise earlier and cover an area of about equal extent. The anal furrow is strongly arcuate, being bent strongly in the middle and terminating slightly further out than the humeral field. The anal veins consist first, of two rather distant nervules subparallel and next to the anal furrow, and next, of two sets of offshoots of the inner of these, the outer of which form, with these, a subfusiform series directed toward the tip of the anal furrow, the other inner set sinuous, crowded, and apparently impinging on the basal half of the border within the anal furrow.

The length of the wing is 10.5 mm.; its breadth 4.1 mm. It comes from the English Purbecks and was kindly sent me for study by Rev. P. B. Brodie to whom I take pleasure in dedicating it.

Mesoblattina Mantelli sp. nov.

Pl. 21, fig. 9.

An almost completely preserved wing, curiously resembling and curiously different from *M. Brodiei*. The veins are of the same color as the rest of the wing, which is slightly dingier than the dirty chalky-white stone. It shows an upper surface, but is somewhat distorted by lying on an uneven surface, so that its convexity is not quite so apparent as it would otherwise be. The anal area has its independent and somewhat marked convexity, and the anal furrow, as well as the inner limit of the flat depressed humeral field, is deeply impressed. The wing is obovate with subparallel sides, but with somewhat irregular shape, the costal margin being straight from the middle of the humeral field to the middle of the outer half of the wing, and then curving strongly and pretty regularly downward to the lowermost part of the rounded apex, where it is met by the uniform and slight arcuation of the inner margin from the anal furrow outward; for the margin of the anal area has an independent arcuation, also regular but much stronger. The whole wing is a little less than three times as long as broad. The humeral field is sublanceolate, finely tapering, reaching more than two-fifths way to the wing tip. The mediastino-scapular vein is very strongly sinuate, terminating just above the tip of the wing, and the costal area is broadest in the middle of the wing where it is scarcely less than half its width; the branches are longitudinally oblique, the basal ones simple, the apical compound, arcuate, and less longitudinal than the basal. The externomedian branches, which are considerably forked apically, arise from two forked branches, which unite close to their divarication opposite the tip of the anal furrow and far within the tip of the humeral field; as a whole they are longitudinally and broadly arcuate. The internomedian branches, few in number and hardly forked, arise scarcely earlier and have a similar course, but are more strongly arcuate basally; they extend far out to the lower angle of the tip of the wing, while the externomedian branches occupy the tip only. The anal furrow is strongly bent in the middle, turning sinuously outward at tip but even then does not extend quite so far as the humeral field. The anal nervules are obscurely preserved, but appear, as in *M. Brodiei* partly to impinge on the basal half of inner margin, partly to converge toward the tip of the anal furrow.

The wing is 10.4 mm. long, and 3.65 mm. broad. It comes from the English Purbecks, and was received from Mr. Brodie. It differs from *M. Brodiei* in the form of

the wing, the shape of the humeral area, the course of the mediastino-scapular vein and the character of its branches, and in the multiplicity of the apical externomedian nervules. It is named in memory of Mantell the English geologist.

Mesoblattina Hopei sp. nov.

Pl. 21, fig. 11.

The fragment of a wing representing this species lacks the apical fifth of the wing and a considerable fragment of the humeral region as well as the anal area. It shows the under surface of the wing, which is a little dingier than the dirty chalky-white stone, being uniformly concave transversely, with the veins slightly sunken on the summits of ridges; although the anal area is gone, the furrow shows slightly prominent as a ridge. As restored in the figure, which seems to indicate its probable form, it was parallel-sided, with a scarcely perceptible taper, and probably a little more than three times as long as broad, for the remains of the costal and inner margins are straight and almost parallel and the veins have a very longitudinal aspect. The mediastino-scapular vein was broadly and gracefully sinuous, plainly terminating at some distance before the tip, most of its branches somewhat longitudinally oblique and compound, the costal area being broadest at the end of the basal third of the wing, where it is scarcely less than half its entire breadth. The externomedian and internomedian veins are longitudinal beyond their base, and even, especially the externomedian, swing upward, the division between the two being probably at the very apex of the wing. The anal furrow, roundly bent very strongly before its middle, takes an oblique course beyond it, but probably does not exceed the basal fourth of the wing.

The length of the fragment is 11.25 mm.; the probable length of the wing 14.25 mm.; its width 4.75 mm. It comes from the English Purbecks, and is named for the late Rev. F. W. Hope who has contributed to our knowledge of fossil insects.

In this vicinity appears to fall another specimen from the English Purbecks (Pl. 21, fig. 6) which is too obscure for extended description. It is a nearly perfect wing, showing the upper surface, but being of the same color as the dirty brown stone it is hard to determine the venation excepting in the most general way. In form it appears to resemble rather closely that presumed for *M. Hopei*, except in being slenderer and having a more acuminate tip. It appears to be more than three times as long as broad, with a large, prominent, sunken humeral field; a scarcely sinuous mediastino-scapular vein, terminating probably above the apex of the wing and having numerous oblique branches, forming an area which occupies nearly half the wing; longitudinal and closely approximate, parallel, median veins; and a comparatively small anal area, the furrow not reaching one-fourth the way out.

Length of wing, 16.7 mm.? ; breadth, 5.5 mm.

Mesoblattina Peachii sp. nov.

Pl. 21, fig. 10.

The nearly perfect specimen which represents this species shows the upper surface of a wing, which is a little dusky on a dirty, chalky-white stone. It is gently convex with

the veins delicately impressed, the anal furrow apparently no more deeply than the others. The wing is very regularly elongate elliptical in form and about two and three-fourths times longer than broad. The extreme base is broken, but the flat humeral field is apically pointed and tapering, and apparently just about as long as the width of the wing. The characters of the costal nervules are just about intermediate between those of *M. Brodiei* and *M. Mantelli*, the area being broadest in the middle, where it is very nearly half the width of the wing and extends to the exact tip of the wing. The externomedian and internomedian veins are also about intermediate between the same two species, though their terminal area is almost exactly as in *M. Brodiei*. It differs, however, from both of these species in the very regular form of the wing. The anal furrow is precisely as in *M. Hopei* and terminates on the margin just short of the tip of the humeral field.

Length of fragment, 10.5 mm.; probable length of wing, 11.6 mm.; breadth of same, 4.1 mm. It is named for Mr. B. N. Peach of the Geological Survey of Scotland, and comes from the English Purbecks.

Mesoblattina angustata.

Blattina angustata Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 288, 299–300, Pl., fig. 6.
Blattina (*Mesoblattina*) *angustata* E. Gein., Zeitschr. Deutsch. geol. Gesellsch., 1880, 519–520.
Mesoblattina angustata Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 114.

This species, which is well figured and described by Heer, is conspicuous among the species of Mesoblattina for its wedge-shaped form, in which it closely resembles a Rithma. The course of the internomedian branches contends, however, against this, and besides, all the anal veins cluster apically toward the tip of the anal furrow, as often in Mesoblattina, and never, so far as known, in Rithma. The costal area occupies half the wing and the humeral field, of which Heer makes no mention, must be very small, slender and short.

Length of wing, 8 mm.; breadth, 2.5 mm. It comes from the Lias of Schambelen, Switzerland.

Mesoblattina Mathildae.

Blattina Mathildae E. Gein., Flötzform. Mecklenb., 29–30, Pl. 6, fig. 1.

This somewhat aberrant form of Mesoblattina has been wrongly interpreted by Dr. E. Geinitz, as he has mistaken the inner for the costal margin and *vice versa*. The base of the wing is broken, but the fragment seems to represent an elliptical wing, a little more than two and one-half times longer than broad, with the lower outer edge rounded off, so as to bring the tip of the wing above the middle line. No trace of a humeral area can be seen, and it must be confined to the broken base and therefore short. The mediasmino-scapular vein (anal and part of internomedian of Geinitz) is pretty strongly and regularly arcuate in the fragment (probably with a reverse curve, so as to be sinuous, toward the base), terminating just above the elevated tip of the wing, broadest in the middle, where it is more than two-fifths of the breadth of the wing, all its branches a little longitudinally oblique and parallel, the basal ones simple, the outer forked or

compound. The externomedian is arcuate at base, first forking opposite the tip of the anal furrow, shortly after which the forking branches become completely longitudinal and occupy apically a very narrow portion of the extreme apex. The internomedian first forks back of the fragment and with its branches has a decidedly arcuate sweep, all the veins in the apical half of the wing being almost completely longitudinal, and impinging at subequal distances along the whole inner margin beyond the anal furrow. In this particular it rather resembles Rithma, but this is brought about by the single fact that the innermost branch, just opposite and close to the tip of the anal furrow, has a forked branch which sends three shoots to the margin close beside it, but for which, all the terminal branches would reach beyond the middle of the wing. The anal furrow is only seen near the end, where it is straight and oblique and probably strikes the margin before the end of the basal third of the wing.

Length of fragment, 18 mm.; probable length of wing, 22.5 mm.; breadth, 8.3 mm. It comes from the Lias of Dobbertin, Germany.

Mesoblattina antiqua.

[Without name] Westw., Quart. Journ. Geol. Soc. Lond., x, 395, Pl. 17, fig. 10.
Rithma antiqua Gieb., Ins. Vorw. 319.
Blattidium antiquum Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 290.
Mesoblattina antiqua Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 115.

This species is peculiar for its remarkable form, the costal margin being nearly straight and the inner and apical margin strongly curved, throwing the apex of the wing far above the middle; in this respect no species but *M. Mathildae* resembles it; but the form is exaggerated in Westwood's figure from the fact that the base is wanting, which, if supplied, would probably make the wing about two and one-half times longer than broad, instead of the extreme brevity of only twice as long, as the fragment is. Marginal field and anal area are altogether wanting in the preserved portion, although it is probable that the anal furrow is shown; in which case the latter must have had a sinuous course from a strong outward curve at tip, and have terminated considerably beyond the basal third of the wing. The mediastino-scapular vein is very sharply sinuous, terminating at the elevated tip of the wing and making the costal area twice as broad (half the breadth of the wing) in the middle of the outer, as in the middle of the inner half of the wing, its branches very longitudinally oblique, the generally simple basal ones more so than the outer ones. The externomedian is much more important than the internomedian vein, occupying more than twice the area, and as much marginal space, its forking branches uniformly and rather strongly arcuate throughout, apically parallel to the outer branches of the costal area.

Length of the fragment, 7.25 mm.; probable length of wing, 9 mm.; its breadth, 3.5 mm. It comes from the Lower Purbecks of Durdlestone Bay, England. It will possibly be found to belong in Elisama.

Mesoblattina? lithophila.

Musca lithophila Germ., Acta Acad. Leop.-Carol., XIX, 222, Pl. 23, fig. 19; Weyenb., Arch. Mus. Teyl., II, 256–257, Pl. 34, fig. 2; Assm., Bericht Vers. deutsch. Naturf. L, 192.

Blattidium Beroldingianum Heer, Viertelj. naturf. Gesellsch. Zürich, IX, Pl , fig. 8.

Assmann is probably correct in referring Heer's species to the one earlier described by Germar, and it appears probable that it belongs to this genus, though no figures good enough to make it certain have yet been published, and its reference here is only by way of suggestion.

The upper wings are 16 mm. in length and the species comes from the Jurassic beds of Solenhofen, Bavaria.

ELISAMA Giebel (emend.)

Elisama Giebel, Ins. Vorw., 320; Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 113.

Although Giebel misinterpreted the neuration completely, interchanging the costal and inner margins, the species on which he founded the genus form a natural group, to which I am now able to add others; his name may, therefore, be retained. The wings are not so slender, generally, as in Mesoblattina and Rithma, and are more nearly allied to the former, but the characteristics by which that is distinguished from Rithma are here intensified. In none of the species known to me are there any specimens in which the base is completely preserved, but what remains are preserved show, without reason for doubt, that the wings are most peculiar in this very region. There is no sign in any of them of any separate humeral field, so characteristic of Rithma and Mesoblattina, and if it existed it must have been very slight. The anal area is also exceptionally small and unimportant, rarely extending a fifth way down the wing and having a very slight breadth, the anal furrow appearing to be either straight or bent in a sense the reverse of usual, taking rather the direction of the anal angle of the wing. In consonance with this, the median branches and especially the internomedian are more sharply bent than even in Mesoblattina (though some species of the two genera agree fairly well here) and fill the inner half or more of the wing with longitudinal veins, so that this region is in marked contrast to the costal with its oblique branches. The median branches seem to be always numerous, and, excepting in one instance, do not reach the border before the distal half of the wing.

The genus is tolerably abundant in species, most of which are found in the English Purbecks; one, however, doubtfully referred here, belongs to the Swiss Lias.

Elisama Molossus.

Blattidium Molossus Westw., Quart. Journ. Geol. Soc. Lond., IX, 384, 394, Pl. 15, fig. 26.

Nethania Molossus Gieb., Ins. Vorw., 321.

Giebel founded the genus Nethania upon this single species, upon characters drawn

from the supposition that the oblique veinlets were those of the anal, while they are really those of the costal area, the margins of the wing having been interchanged in his conception of it. The genus Nethania then might be allowed to drop out of sight, even if it did not appear that the species in question should fall into the same genus as the species referred by him to Elisama, in the conception of which, as pointed out above, he made an exactly similar error. The species seems in fact to fall next to *E. Kneri*, having a very similarly arcuate mediastino-scapular vein, terminating, probably, higher than there, and a similar sweep and manner of forking of the median veins, and, besides, a spot near the base of internomedian area (but farther out than in *E. Kneri*) apparently made up of numerous cross veins; but the basal sinuation of the main vein is much greater than is possible in *E. Kneri* and the basal arcuation of both externomedian and internomedian nervules, especially the latter, is so much less marked, so comparatively slight indeed, that it was not at first recognized as a member of this group, of which indeed it must be looked on as a rather aberrant form.

Length of fragment, 8 mm.; probable length of wing, 10.5 mm. The breadth is too uncertain in the figure to give any definite statement. The specimen comes from the middle Purbecks of Durdlestone Bay, England.

Elisama Kneri.

Pl. 21, fig. 1.

[Without name] Brodie, Foss. Ins. Engl., 118, Pl. 5, fig. 1.
Elisama Kneri Gieb., Ins. Vorw., 320.
Blattidium Kneri Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 291.

I have received from Mr. Brodie the original of his illustration, of which I give a new figure showing the wing to be less complete than his plate would lead one to suppose. Only about half the wing remains, but this the most important part, more than a third, probably, of the tip being broken off, and a not unimportant part of the base. The straight, scarcely divergent costal and inner margins of the fragment indicate, with the neuration, a form like that restored, which, if correct, would make the wing about two and one-third times longer than broad and broadest just beyond the middle. The mediastino-scapular vein has a very strong arcuation, strongest on the basal side, since beyond, by successive forks, it loses the strength of its arcuation and is probably carried to the very tip of the wing; the greatest width is before the middle of the wing, where the costal area is considerably more than two-fifths the breadth of the wing; the basal branches are simple and oblique, those beyond forked or compound and increasingly longitudinal. The externomedian branches are all superior, the internomedian all inferior, but all take a common arcuate sweep so as to be longitudinal in the middle of the wing, and the former probably occupy on the margin only the lower half of the tip. Between all the veins which reach the margin are intercalaries, and where the internomedian nervules commence to become longitudinal, *i. e.*, just where the lowermost approaches the border, they are obscured by a large roundish fuscous spot, which nearly crosses the entire field. The anal furrow and anal area are lost in the broken base of the wing, but must have

been very small. An under surface is exposed on the dirty light brown stone, scarcely darker than the stone itself, with veins and intercalaries black; the surface is almost perfectly flat, only a slight concavity being discernible, and the veins are elevated in the slightest possible degree.

The length of the fragment is 8.5 mm.; probable length of the wing, 13.5 mm.; its breadth, 5.75 mm. The specimen comes from the Purbecks of Wiltshire, England.

Elisama minor.

Pl. 21, fig. 13.

[Without name] Brodie, Foss. Ins. Engl., 118, Pl. 5, fig. 20.
Elisama minor Gieb., Ins. Vorw. 320.
Blattidium minor Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 291.

A specimen received from Rev. Mr. Brodie seems to me to represent pretty certainly the original of his illustration of this species (represented, as usual, reversed on his plate). But even if it is not, it certainly belongs to the same species, and its examination shows that, as in the single specimen of *E. Kneri*, the base is badly broken, and about a quarter of the tip lost; nevertheless the most important part of the neuration remains and enables us to restore the wing with considerable confidence, by which it would appear to be nearly two and one-half times longer than broad and to have had a more convex costal margin than *E. Kneri*. An under surface is exposed, of the same color as the dirty brown stone on which it lies, with black or blackish brown veins and intercalaries. The surface is flat or scarcely concave, the veins scarcely elevated, and the intercalaries slightly sunken. The mediastino-scapular vein is moderately and very regularly arcuate throughout, terminating probably just above the extreme tip of the wing, its branches quite as in *E. Kneri;* the width of the costal area, which is broadest just before the middle of the wing, is here scarcely less than half that of the wing. The externomedian and internomedian branches, by a strong arcuation at base, almost immediately take on a longitudinal and parallel course, filling the space below with very straight veins, those of the externomedian occupying apparently a very narrow space on the extreme tip of the wing. On their basal half or third, farther out next the inner margin than above, these veins are crossed by numerous cross veins, and in the same place as in *E. Kneri* is a pretty large roundish dusky patch. There are intercalaries between all the veins. The anal furrow, which is perfectly flat, is bent in the middle at a broad angle in the same direction as the inner angle of the wing.

The length of the fragment is 5.5 mm.; the probable length of the wing 7.75 mm.; its breadth 2.1 mm. The specimen comes from the English Purbecks and bears also the name "Blake," probably the collector.

Elisama Bucktoni sp. nov.

Pl. 21, figs. 8, 12.

Two specimens, submitted to me by Mr. Brodie, represent this species, neither of them with the base quite perfect, and one with about one-fifth broken from the tip.

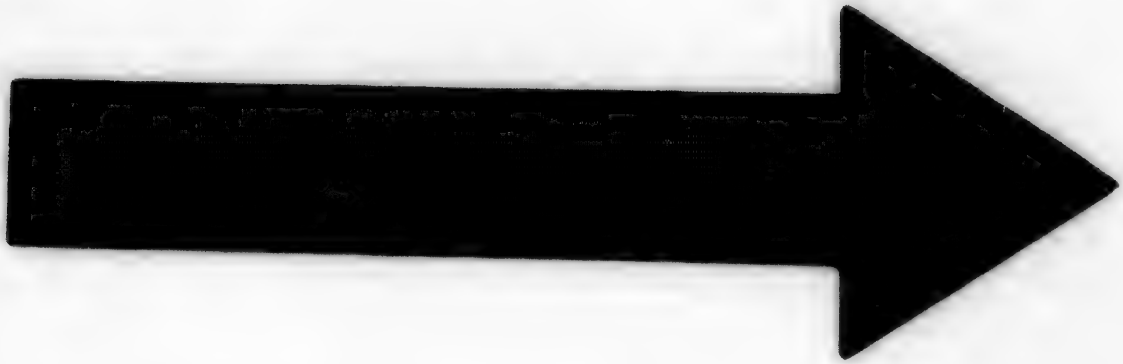
Both of them show the upper surface transversely, slightly and regularly arched, with the delicate veins impressed sharply and slightly in the basal half of the wing, while in the apical half they run as slight ridges at the bottom of flattened furrows between slight, rounded ridges, the ridges scarcely narrower than the furrows and the passages from one to the other being gradual. One of them, fig. 12, is of the same color, veins and all, as the dirty light brown stone, and has the anal furrow a little more deeply impressed than the other veins; the other, fig. 8, is slightly discolored and rests on a dirty chalky-white stone, and the anal furrow is obscure, although apparently impressed no more deeply than the others; where the costal border of this specimen is best preserved it is seen to be narrowly margined. The wings are somewhat more than two and one-half times longer than broad, are broadest just before the middle of the basal half, beyond which they taper very slightly and regularly to about the middle of the apical half, when, especially by the rounded excision of the inner margin, they narrow much more rapidly and terminate in a somewhat pointed shape, the apex above the middle line of the wing; along most of their course both costal and inner margins are straight or very nearly straight. The mediastino-scapular vein is very broadly and pretty uniformly arcuate, terminating just above the extreme apex of the wing, and, excepting two or three simple ones close to the base, all the branches are arcuate, parallel, oblique and strongly compound, so that comparatively few originate directly from the main stem, while a very large number of crowded nervules reach the margin; at its extreme breadth, about the middle of the wing, the costal area occupies a little more than two-fifths the width of the wing. The externomedian and internomedian veins are broadly sinuous, being almost longitudinal in the middle, pretty strongly arcuate in one sense next the base, and gently arcuate in the opposite next their pretty uniformly forking tips where they curve downward to strike the margin, the externomedian terminating upon the apex and extreme apical end of the inner margin, the internomedian beyond the middle of the inner margin. The anal furrow is a straight oblique line, apparently curving downward at extreme tip, in one specimen (fig. 12) terminating at no further than one-fifth of the way from the base, and leaving necessarily an extremely small anal area.

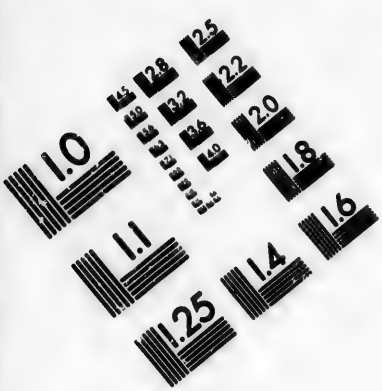
Length of one specimen (fig. 8) 10.6 mm.; breadth 4 mm.; of the other (fig. 12) 8 mm.; probable length of wing 10.1 mm.; breadth 3.75 mm. Both specimens come from the English Purbecks; the species is named for Mr. G. B. Buckton, who, in a recent monograph of British Aphides, has not neglected the fossil species, whether British or foreign.

Elisama Kirkbyi sp. nov.

Pl. 21, fig. 3.

A wing from which the base and one-third of the tip are lost represents this species, which nevertheless plainly belongs in this genus and is very distinct from the other species, the neuration being so regular that it could be restored in the missing apical portion with high probability of accuracy, though the form of this part is more conjectural. As restored, the wing was probably rather more than two and one-half times longer than broad. It represents an under surface, being uniformly concave, and is of the same





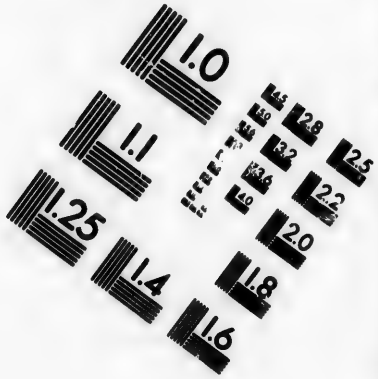
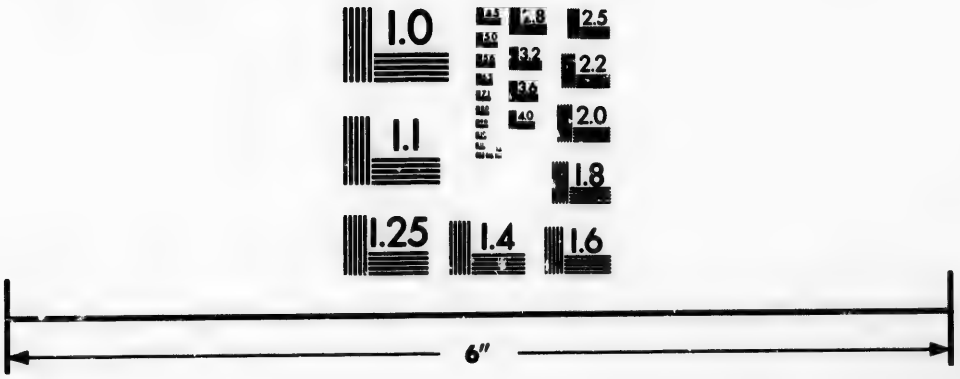
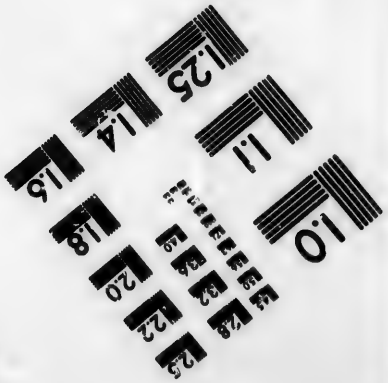


IMAGE EVALUATION
TEST TARGET (MT-3)





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color, veins and all, as the dirty, chalky-white stone on which it rests, the veins being slightly impressed on the summits of rounded ridges separated by transversely rounded furrows. The mediastino-scapular vein is straight in the basal half of the wing; beyond curves slightly and probably terminates a little above the tip with, so far as can be seen, only simple or basally forked, parallel, oblique, scarcely sinuous branches, the costal area being slightly less than two-fifths the breadth of the wing. The externomedian and internomedian veins are strongly arcuate at the extreme base; beyond completely longitudinal in the externomedian area, probably terminating in a narrow space at the extreme tip of the wing, and the same, but slightly declivous, in the internomedian area, where from this cause they terminate along the entire inner margin, even within the basal half of the wing; in the median areas, the interspaces are generally seen to be broken by dull cross veins into quadrate cells, but near the middle of the wing both veins and cross veins are effaced by imperfect preservation. The anal furrow is transversely oblique with no distinction of impression and must terminate at a very short distance out. The species is remarkable for the straightness and simplicity of its costal area, the early termination of its earlier internomedian nervules and its uniform breadth.

Length of fragment, 7.5 mm.; probable length of wing, 14 mm.; breadth, 4.5 mm. The specimen was received from Rev. Mr. Brodie, as from the English mesozoic beds, but without further indications. It is named for Mr. J. W. Kirkby, who has made us acquainted with some of England's earliest fossil cockroaches.

Elisama ? media.

Blattidium medium Heer, Viertelj. naturf. Gesellsch. Zürich, IX, 289, 300, Pl. fig. 7.

An obscure and imperfect specimen, which agrees better with this genus than any other and probably belongs here and to a species distinct from any others known, being distinguished for its tapering form, its straight inner margin, while the costal margin is convex, the regular narrowing of its costal area, which is broadest close to the base and which probably terminates at the very upper extremity of the apex, its intercalary veins and the complete longitudinality and straightness of its median veins.

Length of fragment, 8 mm.; probable length of wing, 10.25 mm.; breadth, 3.5 mm. It comes from the Lias of Schambelen, Switzerland.

b. The externomedian vein of the upper wings is amalgamated either with the scapular or with the internomedian, and all other veins are independent.

PTERINOBLATTINA Scudder.

Pterinoblattina Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 105.

Among the fossil cockroaches figured by Westwood thirty years ago, was one which Giebel afterwards named *Blatta pluma*, on account of the resemblance of its neuration to the barbs of a feather, with the shaft on one side. Several species are now known, including one described as an hemipteron by Germar nearly fifty years ago, and on

account of this curious arrangement of the veins, I proposed recently the generic name here employed. The wings are very broad, expanding considerably beyond the base, broadest beyond the middle, and filled with an abundance of branching veins. The mediastinal, scapular and combined externomedian and internomedian veins run close together, side by side, in a perfectly straight course (the shaft of the feather) from near the middle of the base of the wing toward and nearly to a point on the costal margin a little within the apex of the wing, and the superior mediastinal and scapular and inferior externomedian and internomedian branches, crowded closely together, part from this apparently common stem at nearly similar angles on either side of it; while the anal area, at least where known, occupies a considerable and nearly equal band along a considerable portion of the inner margin, running into and often strongly interfering with the internomedian nervules. As stated in the introductory portion of this paper, what was formerly regarded by me as internomedian is now looked upon as unquestionably anal, so that we can only interpret the neuration by supposing the externomedian and internomedian veins to be amalgamated, and this will remove the genus from the Palaeoblattariae.

The genus was tolerably prolific in species, which vary greatly in size, the two species from the middle Oölite of Solenhofen being particularly large, while one of the Liassic species from Germany is one of the smallest of mesozoic cockroaches. Four species (including two doubtfully referred here) are known from the middle and lower Purbecks of England, two from the middle Oölite of Bavaria and three from the Lias, one in Germany and two in England.

Pterinoblattina pluma.

Pl. 22, figs. 7, 8°.

[Without name] Westw., Quart. Journ. Geol. Soc. Lond., x, 384, 394, Pl. 15, fig. 14. (2 figs.)

Blatta pluma Gieb., Ins. Vorw., 322.

Pterinoblattina pluma Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 105–106.

The specimen, the original of which I have had the privilege of studying, by the favor of my kind friend Rev. P. B. Brodie, is rather imperfect, and a little deceptive from the fact that just that portion of the tip is missing which contains the scapular branches; it is probable, however, from the longitudinal character of the apical offshoots of the median vein that the species more closely resembles *P. chrysea* than *P. intermixta*. There is no discoloration of the stone to mark the wings, though the veins are pale; no portion of any margin is preserved; it lies flat upon the stone, but the scapular vein is slightly depressed while the others with their branches are slightly elevated, by which it would seem that the under surface were uppermost. All the mediastinal branches are simple, parallel, equidistant, almost straight, closely crowded, and part from the main stem at an angle of about 45°. The median branches, the only others preserved, part at a less angle, gradually become quite horizontal apically, are nearly as close at base as the scapular branches, and as most of them fork and even re-fork, though with entire irregularity, become excessively crowded toward the margin.

The length of the fragment is 9 mm.; its breadth 5 mm. Probably the wing was 12 mm. long, and 5.5 mm. broad. It was found in the Corbula or Pecten beds of the middle Purbecks of Dorset, England.

Pterinoblattina penna.

Pl. 22, fig. 14.

Pterinoblattina penna Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 106.

The single specimen of this species at hand is preserved in much the same manner as the last, but shows a fragment of the anal region. The specimen is of the same color as the dirty chalky-white stone on which it rests. The median area is scarcely concave, the vein depressed; the mediastinal area is slightly convex and its main stem is elevated above the two next below it. The three principal veins approach each other very gradually so as to give them the appearance of a tapering rod. The mediastinal branches part from the stem at nearly a right angle near the base of the wing, gradually increasing in obliquity distally, until they form an angle of 45° with it; they are slightly curved, the concavity outward, very closely crowded, and about every third one forked near the middle, but with no regularity. The scapular branches are not preserved, but as in *P. pluma*, and for the same reason, they probably resemble *P. chrysea* rather than *P. intermixta*. The median branches are very closely crowded, generally straight, part from the stem at an angle of 45° next the base, and become almost wholly longitudinal at the apex; they fork about as frequently as, and more irregularly than, the mediastinal branches. The anal area extends far out on the wing, and its branches (what few can be seen) resemble those of the preceding area, and at its extremity are parallel to them.

Length of fragment, 13 mm.; width, 9 mm. Probable length of wing, 15 mm.; probable width, 9 mm. Described from a specimen from the English Purbecks sent me for examination by Rev. P. B. Brodie.

It is not impossible that the fragment of a larger wing figured without name by Westwood (Quart. Journ. Geol. Soc. Lond., x, Pl. 17, fig. 7), from the Lower Purbecks of Durdiestone Bay, may be a species very close to this, if indeed it is not the same.

Pterinoblattina chrysea.

Blattina chrysea Gein., Zeitschr. Deutsch. geol. Gesellsch., 1880, 520, Pl. 22, fig. 2.
Pterinoblattina chrysea Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 106–107.

In this case we have a more perfect wing, the tip being almost completely preserved. The mediastinal vein terminates before the middle of the outer half of the costal border, and is furnished with simple, straight, oblique branches, not so numerous as in the other species, to judge by the figure, though they are spoken of by Geinitz as "very numerous and closely crowded." Just before the scapular reaches the tip of the mediastinal, it turns parallel to the costal margin, runs to the upper tip of the wing, and emits branches similar to those of the mediastinal, but of course of equal length. All the median branches run almost longitudinally, are straight, sometimes forked, and appear from the

figure to be less crowded than the mediastinal branches, though they are compared by Geinitz to the barbs of a feather. The anal runs to just beyond the broadest part of the wing, being thus longer than the mediastinal, and sends less crowded, gently curved, usually forked, rather short branches to the border. The few anal branches curve and strike the inner margin.

Length, 5 mm.; breadth about 2.25 mm. From the Lias of Dobbertin, Germany. The description is drawn up from the data given by Geinitz.

Pterinoblattina Curtisii sp. nov.

Pl. 22, fig. 16.

The fragment of only a tip of a wing represents a species apparently about midway between *P. chrysea* and *P. intermixta*, approaching the latter in delicacy and multiplicity of its crowded neuration, the former in the disposition of the scapular vein and its branches. It is independent of both in the pointed, almost falcate shape of the tip of the wing. The scapular and median veins and branches are the only ones preserved. The former runs parallel to, and at but a short distance from, the declivous curve of the outer part of the costal margin and sends frequent, longitudinally oblique, apically forked branches to the margin, ending at the extreme pointed tip of the wing. The median veins are numerous, straight, parallel to each other and to the apical portion of the scapular vein, and forked pretty uniformly when about as far from the margin as the width of the scapular area.

The length of the fragment is 19 mm.; probably the wing was of twice this length. It comes from the Upper Lias of Alderton, Gloucestershire, England, and was received from Rev. P. B. Brodie. It is named for one of the first English naturalists who interested himself in fossil insects.

Pterinoblattina intermixta.

Pl. 22, fig. 9.

Pterinoblattina intermixta Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 107–108.

A nearly complete wing of this species has almost the same shape as *P. chrysea*, but the upper part of the apex is more produced, though not at all pointed as in *P. Curtisii*. The mediastinal vein terminates before the middle of the outer half of the wing, and the area narrows more gradually than in any of the others; its branches are gently curved, and often forked, but not excessively crowded. Just before reaching the tip of the mediastinal, the scapular vein suddenly bends toward the apex, running subparallel to, but away from, the costal margin, terminating at the tip and emitting a crowd of curved and forked branches. The closely crowded median branches part at an angle of 45° with the stem, are straight, and fork only just before the tip, forming a tolerably regular belt of crowded veinlets along the margin. The basal branches, however, are interfered with and affected by the anal vein, which is nearly straight, at first running plump against the median branches, curves then downward parallel to these and terminates a little before the mediastinal; it is furnished abundantly with branches curving like its extremity and

branching next the border like the median branches, but where it abuts against these latter, they simulate the appearance of the anal branches so as to appear as if a part of the anal area, and thus give the latter the appearance of extending out beyond the broadest part of the wing. The specimen is of a slightly glistening, dark brown color on a dirty brown stone, the veins and all the nervules sharply though only slightly impressed, while the whole wing is at a dead level.

Length of fragment, 10.5 mm.; probable length of wing, 12 mm.; breadth, 5.75 mm. Received from Rev. P. B. Brodie, as coming from the Upper Lias of Alderton, Gloucestershire, England.

Pterinoblattina hospes.

Ricania hospes Germ., Acta Acad. Leop.-Carol., XIX, 220–21, Pl. 23, fig. 18.
Pterinoblattina hospes Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 108.

Germar took this for one of the Fulgorina, in the neighborhood of Ricania and Poecilloptera. Assmann thought it a neuropteron, falling in the neighborhood of Drepanopteryx. It is pretty plain, however, that it belongs here, though the figure given by Germar is not sufficiently clear to enable one to formulate any characteristics. It would seem, however, that the scapular vein probably terminated on the costal margin some way before the tip, and that the latter is shaped much as in *P. intermixta*, and occupied by median branches only; these are more oblique and the lower outer angle much less prominent than in *P. intermixta*, while in the present species the anal angle is prominent and the anal area extended by that alone, occupying a very oblique equal basal band.

It comes from the Oölite of Solenhofen, and measures about 25 mm. in length and 13.5 in breadth.

Pterinoblattina gigas.

Ricania gigas Weyenb., Arch. Mus. Teyl., II, 270–71, Pl. 35, fig. 23.
Pterinoblattina gigas Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 108.

Following Germar, Weyenbergh placed this enormous species in Ricania, but it evidently falls here and bears a close general resemblance, excepting in size, to *P. penna* of the Purbecks. It differs from *P. hospes*, which it most resembles, in the greater extension of the scapular area, which nearly reaches the tip, and in the far wider extension and angular protrusion of the anal angle.

It measures 60 mm. long and 35 mm. broad, and comes like the last from the Oölite of Solenhofen, Bavaria.

Pterinoblattina? Sipylus.

Sialium Sipylus Westw., Quart. Journ. Geol. Soc. Lond., X, 390, 396, Pl. 18, fig. 24.

Westwood considered this to represent "a wing of an insect allied to Sialis," while of the closely allied form, *P. Binneyi*, he says it appears "to be orthopterous." An examination of the series of wings here ranged under the name of Pterinoblattina will convince any one of the close proximity to them of these two abnormal wings; in their elongated form they are indeed entirely different, and were they certainly comparable as front wings

they should be separated generically; but their close resemblance in neuration, which is at the same time in most parts of the wing less dense, leads me to suspect that they may really be hind wings of species of Pterinoblattina of a more elongate form than any yet known (the species vary considerably in this direction), and that for this reason it may be well at least for the present to place them here, doubtfully. The wing referred to the present species is between three and four times longer than broad, subequal, tapering to a somewhat pointed but rounded tip, the latter on the middle line. The scapular branches succeed the mediastinal, in a common, equal, narrow band, which follows the costal margin to just below the tip; the anal area, in a broader, apically tapering band, with much more distant nervules, reaches to the middle of the outer half of the wing; while the long and sinuous, basally distant, apically crowded and forked median veins occupy the intervening space.

Length of fragment, 21.5 mm.; probable length of wing, 24 mm.; breadth, 6.6 mm. It comes from the lower Purbecks of Durdlestone Bay, England.

Pterinoblattina? Binneyi.

[Without name] Westw., Quart. Journ. Geol. Soc. Lond., x, 390, 396, Pl. 18, fig. 42.

This wing has the same general form and proportions as *P. Sipylus* excepting that the extreme tip of the wing is next the lower margin and not on the middle line, but the scapular area still holds the same relation to it as in that species, bending downwards and embracing it. The anal area is more uniformly tapering and does not extend quite so far, giving ampler space for the median nervules, which appear (they are not so exactly delineated) to have the same character as in *P. Sipylus*. It is a considerably smaller species.

Length of fragment, 10.5 mm.; probable length of wing, 12 mm.; breadth, 3.75 mm. Lower Purbecks of Durdlestone Bay, England. Named for Mr. E. W. Binney.

Blattidium Westwood (restr.).

Blattidium Westwood, Quart. Journ. Geol. Soc. Lond., x, 394, 396, without description; Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 111–112.

Westwood designated four of the considerable number of mesozoic cockroaches which he figured in 1850 by the name of Blattidium. One of these, *B. Molossus*, was afterwards taken by Giebel as the type of his Nethania, based on an entirely wrong conception of the neuration, and which, as we have seen above, falls properly into his genus Elisama. A second species, *B. Achelous*, is probably neuropteroid, and will not be considered here. The other two form a second very peculiar type of cockroaches, quite as strange as Pterinoblattina, though very different from that, both from their long, slender and parallel-sided form, and from the union of the externomedian and scapular veins for nearly half their length. The mediastinal vein terminates not far from the middle of the wing, and sends out a multitude of crowded offshoots to the margin. The united

scapular and externomedian vein runs parallel to the border, to which, as well as to the mediastinal vein before it terminates, it sends rather distant, oblique veins, besides an inferior longitudinal branch, which has several very distant, inferior, equally longitudinal offshoots. The internomedian vein is wholly longitudinal, and has few distant branches; these apparently terminate only in the apical border, while the main anal vein, longitudinally oblique, extends nearly as far as the mediastinal, and the outer half of the inner margin of the wing seems to have no veins falling on it; the veins of the anal area run obliquely from the margin upward and outward to the main anal vein.

The two species known come from the Lower Purbecks of England.

Blattidium Simyrus.

Pl. 22, fig. 17.

[Without name] Brodie, Foss. Ins. Engl., 118, Pl. 5, fig. 19.
Blattidium Simyrus Westw., Quart. Journ. Geol. Soc. Lond., x, 390, 396, Pl. 18, fig. 33
Gryllidium Oweni Westw., Quart. Journ. Geol. Soc. Lond., x, 387, 395, Pl. 17, fig. 19.

The figure here given is made up from two specimens, obverse and reverse, of the type of Westwood's *B. Simyrus*, which Mr. Brodie has kindly sent me. The mediastinal area is slightly lower than the rest of the wing and the mediastinal vein deeply depressed. The species is peculiar for the fineness and irregularity of the mediastinal nervules, which are in strong contrast to the distant and regular scapular superior branches, and these in their direction and brevity to the dozen longitudinal veins belonging to the median series. The anal area is filled with oblique transverse veins having the same direction and about the same distance apart as the superior scapular nervules. An inferior marginal vein borders the under surface of the wing.

Length of fragment, 25 mm.; possible length of the wing, 42 mm.; breadth, 6.5 mm. It comes from the Lower Purbecks of Durdlestone Bay.

It seems highly probable that *Gryllidium Oweni* Westw., which comes from the same place and is of the same size, is a specimen of the same species, in which the subordinate nervules of the mediastinal and anal areas are not preserved; the latter are not delineated in Westwood's figure of this species. Brodie's Pl. 5, fig. 19, which Westwood took to be the folded hind wing of a cricket, seems also probably to fall here, though it may indicate another species in which the superior scapular branches are as crowded as the mediastinal.

Blattidium Nogaus.

Blattidium Nogaus Westw., Quart. Journ. Geol. Soc. Lond. x, 390, 396; Pl. 18, fig. 23.

I have not seen this species, which has a proportionally much broader mediastinal area, and apparently a smaller number of median veins than the other. The wing could hardly have had the excessive slenderness of the other species, the fragment being 18 mm. long and 7 mm. broad, and the whole wing probably not more than 27 mm. long. It too comes from the lower Purbecks of Durdlestone Bay, England.

c. The mediastinal and scapular veins of the upper wings are amalgamated, and in addition the externomedian vein is amalgamated either with the foregoing or with the internomedian vein.

NANNOBLATTINA gen. nov. (νάννος.)

In this genus, where all the wings are minute, the externomedian springs from the united mediastino-scapular vein in the second quarter of the wing. The costal field is very broad, while the internomedian area is considerably restricted in width, though it extends a good distance toward the tip. In other respects the different species vary widely.

The three species come from the upper Oölite of England.

Nannoblattina similis.

Corydalis —— Brodie, Foss. Ins. Engl., 119, Pl. 5, fig. 2.
Blattina similis Gieb., Ins. Vorw., 318.

In this species the mediastino-scapular area is regularly arched on either side of the middle of the wing and occupies at most more than half its width, while the externomedian originates nearer the base than in the other species, and leaves a nearly uniform narrow internomedian area.

Length of fragment (from which a small part of the base only appears to be broken) 5 mm.; breadth 2 mm. It comes from the English Wealden.

Nannoblattina Prestwichii sp. no.

Pl. 22, fig. 3.

A nearly perfect wing, but with the anal area lost and the basal part of the costal area. It is possible, however, to restore the missing border with a considerable degree of precision, and so to judge that the wing was tolerably slender, a little less than three times as long as broad, with straight margins, scarcely tapering, the tip well rounded. The mediastino-scapular vein is well arched, so that in the middle of the wing the area occupies nearly half the width; most of its nervules are straight, oblique and simple, but some of the apical ones are forked. The externomedian vein parts from this in the middle of the basal half of the wing, and with its forks occupies nearly the entire tip of the wing. The internomedian is rather strongly sinuous, its area narrow excepting at extreme base, the nervules few, simple, slightly sinuous and longitudinally oblique. The anal furrow is pretty regularly and not very strongly arcuate, terminating beyond the middle of the basal half of the wing. An upper surface is exposed on the light brown stone, but it is perfectly flat; it is a little fuliginous, with blackish brown veins which are just perceptibly impressed, the anal furrow no more than the rest.

Length of fragment 6 mm.; probable length of wing 6.5 mm; breadth 2.25 mm. The specimen comes from the English Purbecks and was studied by the favor of Rev. P. B. Brodie. It is named in honor of the veteran English geologist.

Nannoblattina Woodwardi sp. nov.

Pl. 22, fig. 6.

This minute species is represented by a single nearly perfect wing, broken obliquely across the base. An under surface is exposed on the dark greenish gray stone, as appears from its slight concavity, and the prominent veins; the wing is fuliginous and the stout veins broadly marked in black. The wing is comparatively broad, the costal and inner margins straight and parallel, the tip broadly rounded, the apex slightly above the middle. The mediastino-scapular vein runs in an obliquely and gently sinuous course, terminating below the apex and broadest in the whole apical third of the wing, where it occupies fully half of its width, furnished with considerably arcuate, rather numerous, parallel, simple, oblique branches. The externomedian vein arises from this in the middle of the second fourth of the wing and is but once forked, near the tip. The internomedian vein is strongly sinuous, the area rapidly narrowing and the branches very few, short and somewhat divergent. The anal furrow is scarcely or not at all more distinct than the other veins, is strongly arcuate and must enclose a very large anal area, but the broken wing will not allow us to determine how much; it is probable, however, that it reaches nearly to the middle of the wing; the anal veins are simple, parallel, impinge on the margin, the basal ones turned apically a little outward.

Length of fragment 3.75 mm.; probable length of wing 4.1 mm.; its breadth 1.6 mm. It comes from the Wiltshire Purbecks, was received through Rev. Mr. Brodie and is named for Dr. Henry Woodward who has introduced to us so much of the life of the past.

DIPLUROBLATTINA gen. nov. (δίς, πλευρόν)

In this genus the externomedian vein has become completely amalgamated, not with the mediastino-scapular but with the internomedian. The humeral field again appears and, notwithstanding the amalgamation mentioned, the mediastino-scapular area occupies a very large share of the wing, which is of a tapering, cuneiform shape in the only species known. The veins are, therefore, branches of two principal stems which pass down the middle of the wing side by side, but as distant as the principal branches from each other.

The single species comes from the English Purbecks.

Dipluroblattina Bailyi sp. nov.

Pl. 22, fig. 5.

A nearly perfect wing represents this species in which the anal area only is wanting, excepting a minute fragment of the tip. It has a tapering, graceful form, both costal and inner margin being similarly and gently arcuate and the slender tip being well rounded. A smooth and flattened humeral field, lanceolate in shape, extends over about a third of the wing. The mediastino-scapular, strongly arcuate near the base, runs in its apical half nearly through the middle of the wing, terminating scarcely above the tip; its rather numerous branches, simple at first, beyond simple or forked, are oblique and tolerably

straight. The median vein runs parallel to the preceding throughout, has four inferior branches arising tolerably near together just before the middle of the wing, which are very strongly arcuate, simple or forked, apically longitudinal; in the apical third of the wing, distant in origin from the preceding, are a couple of simple longitudinal branches. The anal area cannot extend beyond the basal fourth of the wing.

Length of fragment 6.75 mm.; of wing restored 7.5 mm.; breadth 2.65 mm. The wing, which is scarcely dingier than the chalky-white stone on which it rests, showing its upper domed surface with the slightly dusky veins minutely depressed, is faintly and very delicately reticulated in the basal half. It comes from the English Purbecks, lies side by side with the Mesoblattina figured on Pl. 20, fig. 3, and was received from Rev. P. B. Brodie. It is named for Mr. W. H. Baily who has interested himself in some of the fossil insects of Ireland.

Diechoblattina gen. nov. (διέχω)

This genus is nearly allied to the last, all the veins of the wing being dependencies of two stocks, which as there pass down the middle of the wing, the veins diverging in opposite directions; but here these main stems are very closely approximated and appear to terminate before the tip of the wing, leaving the longitudinal branches only to run to the tip. The humeral field also is wanting. All the branches, as a mass, are arcuate, the superior ones with the arcuation opening toward the basal half of the costal border, the inferior toward the apical half of the same.

The two species are found in the English Purbecks.

Diechoblattina Ungeri.

[Without name] Westw., Quart. Journ. Geol. Soc. Lond., x, 395, Pl. 17, fig. 13.
Blatta Ungeri Gieb., Ins. Vorw., 322.

This minute species has much the appearance of a feather. The two main stems run close together in a regular gently arcuate course nearly to the tip, the arcuation opening toward the costal margin.

Length of wing, 5.5 mm.; breadth, 2.5. Lower Purbecks of Durdlestone Bay.

Diechoblattina Wallacei sp. nov.

Pl. 22, fig. 1.

Restoring the wing at its broken base, as in the figure, the approximated stems are seen to run in a straight, scarcely oblique course through the basal third of the wing, beyond which, in more delicate shape, they are regularly and considerably arcuate, terminating in the middle of the very broadly rounded tip. Most of the nervules are simple, the superior ones rather more crowded than the more strongly arcuate and more longitudinal inferior ones, and those arising in the apical half of the wing usually more or less forked. The costal margin is very gently convex, and the apex of the wing roundly docked; anal area broken off.

Length of fragment, 8 mm.; probable length of wing, 9.75 mm.; breadth, 4 mm. The specimen is of the same color as the dirty, chalky-white stone on which it is preserved and exhibits apparently the under surface, the veins being slightly raised; the principal veins are scarcely separable near the base. The species, sent me by Mr. Brodie, comes from the English Purbecks and is named for the English naturalist, Mr. A. R. Wallace, whose studies have embraced fossil insects.

Scutinoblattina Scudder.

Scutinoblattina Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 110.

The tegmina are more or less coriaceous obscuring somewhat the neuration. The mediastino-scapular vein is nearly or quite straight, terminating a little below the tip of the wing, while the median vein (the externomedian and internomedian being united) runs parallel to and somewhat distant from it. The anal veins fall sometimes on the inner margin and sometimes on the anal furrow. All the species are from the American Trias.

The three species are *S. Brongniarti*, *S. intermedia* and *S. recta*, all found at Fairplay, Colorado. They have been briefly described in the Philadelphia Academy's Proceedings, and will be fully discussed and figured in a paper devoted to this Triassic locality, so that it is only necessary here to indicate their position in the series.

Legnophora Heer.

Legnophora Heer, Viertelj. naturf. Gesellsch. Zürich, ix, 297.

Heer gives this name to an object of whose animal nature he was not wholly convinced. If, as he supposed, the front wing of a cockroach, it differs from all known forms in the parallel and longitudinal course of the veins of the costal area. Apparently it falls near this place, and the wing itself appears to have been somewhat coriaceous.

The single species is *L. Girardi* Heer (*loc. cit.*) fig. 5, from the Trias of Trebitz, Germany.

Aporoblattina gen. nov. (ἄπορος).

Under this name, I group a series of wings, of three of which I have seen specimens, which appear to me to be in all probability hind wings of cockroaches. They differ considerably among themselves, but agree in having the mediastinal and scapular veins distinct, the former occupying a narrow belt with longitudinally oblique veins, and in having a very extensive development of the internomedian vein, with long, sweeping, arcuate nervules; the externomedian, in all cases but one or two, where it appears to be either altogether wanting or amalgamated with the internomedian, being very slenderly developed in a very narrow area.

Most of the species come from the upper Oölite of England, but three species come from the Lias, two of them from England and one from Germany.

Aporoblattina Eatoni sp. nov.

Pl. 22, fig. 19.

This specimen is a nearly complete wing of the same color as the light, dirty brown stone on which it is preserved, with very dark brown veins; it is perfectly flat, but the veins are slightly impressed in places; it has the appearance of being the upper surface of a hind wing, partly folded in the partially incomplete anal region. The costal margin is perfectly straight in the basal half, then more and more arcuate, meeting at a broad angle the arcuate curve of the lower part of the wing at the scarcely angulate apex in the middle of the upper half of the wing. The basal half of the costal area appears to be narrowly folded. The mediastinal vein is straight, terminating in the middle of the outer half of the wing, with a few distant, longitudinally oblique, but short, simple branches. The scapular vein is also straight, terminates just below the tip and is furnished with three or four longitudinal, slightly upcurved branches, compound apically, and originating at equal distances far apart, the second in the middle of the wing. The externomedian vein is also straight, first divides in the middle of the wing and is very slightly and longitudinally branched. The internomedian vein, also straight, but slightly declivous to beyond the middle of the wing, then bends slightly downward, and has four slightly arcuate, longitudinally oblique, equidistant and rather distant simple branches. The anal vein has branches similar to the preceding, but, apparently by a fold, they are made to take a more longitudinal course.

Length of wing, 15 mm.; breadth, 6.5. It comes from the English Purbecks, was sent me by Rev. Mr. Brodie, and is named for Rev. A. E. Eaton who has contributed slightly to our knowledge of fossil insects.

Aporoblattina anceps.

[Without name] Westw., Quart. Journ. Geol. Soc. Lond., x, 396, Pl. 15, fig. 22.
Blattina anceps Gieb., Ins. Vorw., 317 (Giebel wrongly quotes fig. 21).

This small species seems to be closely allied to *A. Eatoni*, but of a very different shape, the costal margin being quite as arcuate as the lower margin, or more so, and the bluntly rounded apex being in the middle of the wing. The characteristics of the neuration are in general similar to those of *A. Eatoni*, but the externomedian vein (which is probably wrongly represented as attached at base of fragment to the scapular vein) is only once forked, near the tip, and the branching of the scapular vein is much simpler.

Length of fragment, 7 mm.; probably the wing is not much longer; breadth, 4 mm. Lower Purbecks, Durdlestone Bay.

Aporoblattina McLachlani sp. nov.

Pl. 22, fig. 6.

[Without name] Westw., Quart. Journ. Geol. Soc. Lond., x, 396, Pl. 18, fig. 35.

Westwood looked upon this wing as neuropterous, and apparently as more complete

than it seems to be, its true dimensions being attempted to be shown in the figure here given, which is taken, with scarcely any doubt from the same specimen, now in the collection of Rev. P. B. Brodie. The specimen is slightly duskier than the dirty, chalky-white stone, perfectly flat, with delicately impressed veins which are the clearer for being filled with dirt. Next the anal area another wing partly overlies this, but it is not drawn. The wing was of a sub-oval form with a very much fuller curve below than above, the apex, which is rounded though produced, being in the middle of the upper half of the wing. Only the tip of the mediastinal vein appears on the fragment, and it is very similar to that of *A. Eatoni*, terminating probably a little before the middle of the outer half of the wing. The scapular vein differs from that of *A. Eatoni* considerably, terminating scarcely above the apex and having only simple oblique branches in the outer third of the wing, and a single longitudinal also simple branch, arising one-third the way from the base. The internomedian vein is much as in *A. Eatoni*, but only branches in the apical third of the wing. The externomedian vein occupies an even broader field than in the last species, with similar but more arcuate, and apically more longitudinal branches, also simple. The anal veins are not seen.

Length of fragment, 6.75 mm.; probable length of wing, 8.5 mm.; breadth, 4.75 mm. From the English Purbecks, named for Mr. R. McLachlan, whose well known entomological studies have extended occasionally to fossil insects.

Aporoblattina Westwoodi sp. nov.

[Without name] Westw., Quart. Journ. Geol. Soc. Lond., x, 396, Pl. 18, fig. 28.

Westwood looked on this wing as phryganideous, but it plainly belongs in this immediate vicinity, resembling closely the preceding species, from which it differs in its greater size and slenderness, in the forking of the first branch of the scapular vein (no branch in any part of the wing is forked in *A. McLachlani*) and in the generally less regular disposition of the branches of the scapular area. The externomedian vein is also simpler and less regular.

The fragment is 10.5 mm. long and 5 mm. broad. Probably the wing reached a length of 14 mm. It comes from the lower Purbecks of Durdlestone Bay.

Aporoblattina Kollari.

[Without name] Brodie, Foss. Ins. Engl., 33, 119, Pl. 5, fig. 14.
Blatta Kollari, Gieb., Ins. Vorw., 322.

Westwood, in Brodie's work, looked upon this as belonging to a family of Neuroptera "of which Corydalis is the type." It plainly belongs here, and is apparently not distantly related to the two preceding species and especially to *A. Westwoodi*, from which it is readily distinguished by its still slenderer form, and the greater straightness and regular distribution of its scapular branches.

Length, 18 mm.; breadth, 6.5 mm. It comes from the Purbeck strata of the Vale of Wardour.

Aporoblattina incompleta.

[Without name] Brodie, Foss. Ins. Engl., Pl. 8, fig. 13.
Blattina incompleta Giebel, Ins. Vorw., 317.

This species differs somewhat from the preceding forms and is very imperfect, but seems to belong here, and to be not distantly related to *A. Westwoodi*, but with the externomedian area much more fully developed, with nervules simulating those of the scapular area. Both scapular and anal areas are wanting.

Length of fragment, 8.5 mm.; width of same, 3.75 mm.; probable length of wing, 11 mm.; probable breadth, 4.25 mm. It comes from the English Lias.

Aporoblattina recta.

[Without name] Brodie, Foss. Ins. Engl., 33, 119, Pl. 5, fig. 3.
Blattina recta Gieb., Ins. Vorw., 318.

This also Westwood looked upon as allied to Corydalis, but it is clearly related to the others. It is a small and slender species, but, excepting for the changes in neuration which this involves, closely resembles *A. McLachlani*. The externomedian branches only near the tip and entirely beyond the extremity of the mediastinal area, occupying the tip with its forked branches, which, in contradistinction to all the other veins are both superior and inferior; all the other branches are simple.

Length of fragment, 6.5 mm.; probable length of wing, 8 mm.; breadth, 2.75 mm. It comes from the Wealden of the Vale of Wardour.

Aporoblattina nana.

Blattina nana E. Gein., Flötzform. Mecklenb., 30, Pl. 6, fig. 2.

This minute species appears to belong here, though it differs conspicuously in the more longitudinal and straighter branches, most noticeable in the internomedian area. It is a little difficult to tell where the separation of the scapular and externomedian veins should be placed, as the base is broken, but it would appear probable that Geinitz's construction of the neuration is correct, in which case the very small development of the scapular is a marked feature of the species.

Length of fragment, 5 mm.; probable length of wing, 6.5 mm.; breadth, 2.4 mm. It comes from the Lias of Dobbertin, Germany.

Aporoblattina exigua sp. nov.

[Without name] Westwood, Quart. Journ. Geol. Soc. Lond., x, 390, 396, Pl. 18, fig. 38.

This species, represented by a wing which Westwood regarded as orthopterous, seems to belong here and to be nearly related to *A. nana*, than which it is not much larger. The mediastinal vein runs to the middle of the outer half of the wing. The scapular

vein runs almost straight to the tip, and, commencing to branch pretty near the base, sends four widely and equally distant, superior, and almost longitudinal branches to the margin, which in the outer third of the wing are considerably forked, so that the tip is crowded with terminal branches. The externomedian is similarly branched, but narrowly and only quite beyond the middle of the wing. Even the unusually longitudinal branches of the here comparatively narrow externomedian area are forked in the apical third of the wing. The anal area appears to be brief and narrow with two or three oblique veins. The narrowness of the wing is its marked feature, disguising its resemblance to its allies, next to which is the general multiplication of branches in the apical third of the wing. It is from two and a half to three times as long as broad.

Length of fragment, which is very nearly complete, 9 mm.; breadth, 3.6 mm. It comes from the lower Purbecks of Durdlestone Bay. Heer referred it to Blattidium.

Aporoblattina Butleri sp. nov.

Pl. 22, fig. 15.

A single specimen and its reverse on a grayish-brown stone, in which the surface, perfectly flat, is of the same color, excepting for the reddish-brown veins slightly impressed on one, slightly prominent on the other, represent this species. It is but a fragment, and is the only one placed here which appears to have certainly no externomedian vein; a mere fragment of the costal margin remains, but a conjectural outline is given on the plate, hardly consonant with the idea that it is a hind wing; indeed the presence and character of the anal vein (which is, however, no more depressed than the others) hardly allows that supposition, so that it is probable that it does not belong in this group. Still the neuration strongly reminds one of that of these species, with the single exception of the arcuate anal furrow, and the absence of the externomedian vein. The mediastinal vein extends beyond the limits of the fragment, but undoubtedly stops considerably short of the tip (running at first parallel to (?) and afterwards) approaching the not distant costal margin, with few, distant, longitudinally oblique, nearly straight and simple branches. The scapular vein runs, apparently to the tip of the wing, in a nearly straight course far from the costal margin, yet commences to fork only just before the middle of the wing and has only two or three superior, longitudinal, so far as can be seen simple, distant branches. The median vein runs in a nearly straight course, parallel to the former, through the middle of the wing, and has only a few similarly distant, longitudinally arcuate, so far as can be seen simple veins, all, or all but one of which, arise near together before the middle of the wing. The anal furrow is broadly arcuate, terminating probably a little before the middle of the wing.

Length of fragment, 8.25 mm.; probable length of wing, 12 mm.; its breadth, 4.25 mm. It comes from the English Lias and was sent by Rev. Mr. Brodie for examination. It is named after Mr. A. G. Butler, of the British Museum, who has contributed somewhat to our knowledge of English fossil insects.

APPENDIX.

There are a few species, imperfectly preserved, concerning which we can come to no satisfactory conclusions. Such is *Rithma ramificata* Giebel (figured by Westw., Quart. Journ. Geol. Soc. Lond., x, Pl. 15, fig. 20), in which all the veins, or at any rate all but one are represented as originating from a single root. It is perhaps an Elisama.

Another is *Blattina incerta* Geinitz (Zeitschr. deutsch. geol. Gesellsch., 1884, 571, Pl. 13, fig. 2), which the author compares to *Ctenoblattina Langfeldti*, a resemblance which would not have been mentioned if a mistake had not been made in the interpretation of the margins of the wing of the latter species, as mentioned above. By the distance of the mediastinal vein from the margin, it would appear to be a front wing; but for that and for the corresponding very strongly arcuate front margin, it would appear to be a hind wing, and to be not far removed from the wings I have placed in Aporoblattina. As, however, it is clearly a front wing, as all the veins appear to be independent, and as its general form and the general distribution of the areas are very different from that of mesozoic cockroaches in general, I am strongly inclined to doubt the Blattidean relationship claimed for it, and to look at it rather as a neuropterous wing allied to Hagla.

There is also the mere fragment of a wing figured by Westwood (Quart. Journ. Geol Soc. Lond., x, Pl. 15, fig. 19) which is probably less than a quarter of the whole wing, and the apical portion at that, which is probably quite indeterminate. Heer refers it to Blattidium.

The fragment of a wing figured by Brodie (Foss. Ins. Engl., Pl. 5, fig. 6, *cf.* p. 121) from the Wealden is apparently the anal area of a cockroach, in which the upper curve represents the anal furrow and the lower, with the veins falling on it, the inner margin of that part of the wing. It seems to have belonged to a species about the size of *Rithma Westwoodi*.

The insect from Solenhofen (Jura), which Heyden (Palæontogr., I, 100-101, Pl. 12, fig. 5) figures under the name of *Blabera avita*, but which he says "einer eigenen Gattung angehören mag," on account of the shape of the tegmina, has rather on his plate the appearance of a Cybister or an Hydrophilus, but until further examination of the original or of other specimens, cannot be definitely fixed. There is nothing, either in shape or neuration (which appears to be very obscure), which shows any relation to other mesozoic forms, and with the exception of the Solenhofen species of the abnormal and widely different genus Pterinoblattina, it is very much larger than any other mesozoic forms of this family.

Finally a species from the Jura of Solenhofen is mentioned and rudely figured by Weyenbergh (Periód. Zool., I, 86, Pl. 3, fig. 12) under the name of *Blattaria Dunckeri;* but all he says of it is that it is characterized by the abdominal appendages and the small head. As far as the figure goes, there seems to be nothing to show that it is certainly a cockroach, still less where it belongs; no wings are preserved.

EXPLANATION OF PLATES.

PLATE 20.

Fig. 1. *Ctenoblattina arcta.* ½ Drawn by Katherine Peirson. Purbecks, England.
" 2. " " ½ Drawn by J. Henry Blake.
" 3. *Mesoblattina*, sp. ½ Drawn by Miss Peirson. Purbecks, England.
" 4. *Rithma Stricklandi.* ½ Showing only the left upper wing, drawn by Mr. Blake. Purbecks, England.
" 5. " " ½ The entire insect. Drawn by the same.
" 6. *Rithma Westwoodi?* ½ Drawn by Miss Peirson. Purbecks, England.
" 7. *Rithma liasina.* ½ Drawn by the same. Lias, Strensham.
" 8. *Rithma*, sp. ½ By the same. Purbecks, England.
" 9. *Mesoblattina Geikiei.* ½ By the same. Lias, Brown's Wood, Warwickshire.
" 10. *Mesoblattina Swintoni.* ½ By the same. Purbecks, England.
" 11. *Rithma Westwoodi.* ½ By the same. Purbecks, England.
" 12. *Mesoblattina Blakei.* ½ By the same. Upper Lias, Alderton.
" 13. *Mesoblattina*, sp. ½ By the same. England.
" 14. *Rithma disjuncta.* ½ By the same. Purbecks, Wiltshire.
" 15. *Rithma Gossii.* ½ By the same. Purbecks, England.
" 16. *Rithma Daltoni.* ½ By the same. Purbecks, England.
" 17. *Mesoblattina Bensoni.* ½ By the same. Upper Lias, Dumbleton.

PLATE 21.

Fig. 1. *Elisama Kneri.* ½ Drawn by Katherine Peirson. Purbecks, Wiltshire.
" 2. *Mesoblattina Bucklandi.* ½ By the same. England.
" 3. *Elisama Kirkbyi.* ½ By the same. England.
" 4. *Mesoblattina Murrayi.* ½ By the same. Purbecks, England.
" 5. *Mesoblattina Murchisoni.* ½ By the same. Purbecks, England.
" 6. *Mesoblattina*, sp. ½ By the same. Purbecks, England.
" 7. *Mesoblattina Brodiei.* ½ By the same. Purbecks, England.
" 8. *Elisama Bucktoni.* ½ By the same. Purbecks, England.
" 9. *Mesoblattina Mantelli.* ½ By the same. Purbecks, England.
" 10. *Mesoblattina Peachi.* ½ By the same. Purbecks, England.
" 11. *Mesoblattina Hopei.* ½ By the same. Purbecks, England.
" 12. *Elisama Bucktoni.* ½ By the same. Purbecks, England.
" 13. *Elisama minor.* ½ By the same. Purbecks, England.
" 14. *Mesoblattina Higginsii.* ½ By the same. Purbecks, England.

PLATE 22.

Fig. 1. *Diechoblattina Wallacei.* ½ Drawn by Katherine Peirson. Purbecks, England.
" 2. *Rithma? minima.* ½ Drawn by J. H. Blake. Purbecks, Dorset (see fig. 8*a*).
" 3. *Nannoblattina Prestwichii.* ½ Drawn by Miss Peirson. England.
" 4. Part of the upper wing of an Orthopteron ("Grasshopper," Westwood.) ½ Drawn by Mr. Blake. Purbecks, Dorset (see fig. 8*b*).
" 5. *Dipluroblattina Bailyi.* ½ Drawn by Miss Peirson. Purbecks, England.
" 6. *Nannoblattina Woodwardi.* ½ Drawn by Mr. Blake. Purbecks, Wiltshire.
" 7. *Pterinoblattina pluma.* ½ Drawn by Mr. Blake. Purbecks, Wiltshire (see fig. 8*c*).
" 8. Slab of stone from Purbecks of Wiltshire, showing in their natural size the species represented in figures 2, 4, 7, 10, 11, 12, 13. Compare the figures by Westwood in Quart. Journ. Geol. Soc. Lond., x, Pl. 15, fig. 14. Drawn by Mr. Blake.
" 9. *Pterinoblattina intermixta.* ½ Drawn by Miss Peirson. Upper Lias, Alderton.
" 10. Trichopterous wing, according to Westwood. ½ Drawn by Mr. Blake. Purbecks, Wiltshire (see fig. 8*f*).
" 11. *Rithma? minima.* ½ Drawn by Mr. Blake. Purbecks, Wiltshire (see fig. 8*g*).
" 12. Trichopterous wing, according to Westwood. ½ Drawn by Mr. Blake. Purbecks, Wiltshire. (see fig. 8*d*).
" 13. *Cercopidium Telesphorus*, Westw. ½ Drawn by Mr. Blake. Purbecks, Wiltshire (see fig. 8*e*).
" 14. *Pterinoblattina penna.* ½ Drawn by Miss Peirson. Purbecks, England.
" 15. *Aporoblattina? Butleri.* ½ Drawn by Miss Peirson. Lias, England.
" 16. *Pterinoblattina Curtisii.* ½ Drawn by S. F. Denton. Upper Lias, Alderton.
" 17. *Blattidium Simyrus.* ½ A composite figures from the obverse and reverse together. Drawn by Mr. Blake. Purbecks, England.
" 18. *Aporoblattina McLachlani.* ½ Drawn by Miss Peirson. Purbecks, Eng'and.
" 19. *Aporoblattina Eatoni.* ½ Drawn by Miss Peirson. Purbecks, England.

New Types of Cockroaches from the Carboniferous Deposits of the United States.

SINCE the publication of my revision of the carboniferous cockroaches of the world, a very considerable number of new forms have been described from the Old World and a good many additional kinds have been found in our own country. A few of these from the Richmond, Ohio, coal fields have been described by me, and a very large number more are in my hands awaiting investigation. The forms herewith described (for the first time in full) have been awaiting an opportunity for illustration before final publication, and extend considerably our knowledge of the ancient fauna, several of the species showing much more than the upper wings, upon which we have heretofore mainly depended. The larger part of them come from Mazon Creek, Ill.

MYLACRIDAE Scudder.

As there are two generic forms to add to the three published in my paper on Palaeozoic cockroaches, I add a new table of the genera of this family.

TABLE OF THE GENERA OF MYLACRIDAE.

All the branches of the mediastinal vein arising close to the base of the wing.
- Mediastinal and scapular areas together occupying less than half the wing.
  - Scapular area larger than the mediastinal . . . . . **Mylacris.**
  - Scapular area smaller than the mediastinal . . . . . **Promylacris.**
- Mediastinal and scapular areas together occupying half or more than half the wing.
  - Wings broad; externomedian area expanding apically . . . . . **Paromylacris.**
  - Wings narrow; externomedian area small and compressed, scarcely expanding apically . **Lithomylacris.**

A number of the apical branches of the mediastinal vein arising beyond the base of the wing and scarcely partaking of the radiate arrangement of the others. . . . . **Necymylacris.**

Mylacris mansfieldii.

Mylacris mansfieldii Scudd., Mem. Bost. Soc. Nat. Hist., III, 47 (1879).

A fragmentary and small specimen of this species, affording some points in addition

to the original specimen, has been sent me by Mr. W. F. E. Gurley. It is incomplete and the best face is broken into several fragments, but it shows the greater part of the costal margin with the outer tip of the wing. Though the wing tapers apically, this tip is not at all pointed, as was supposed from the original imperfect specimen, but well rounded, and the costal margin is pretty regularly and gently rounded but a little flattened beyond the basal two-fifths of the wing, where there is a slight change in the curve, due to this flattening. As in the original, two or three of the mediastinal rays are forked near their origin, and the mediastinal area appears to extend a very little further than in the original. What can be seen of the other areas (the scapular vein is nearly complete, but only a little of the others) agrees tolerably well with those of the original specimen, except that the externomedian vein certainly begins to fork at an earlier part of its course, namely at about the same point as the scapular vein. The wing is preserved a little further toward the base than the original, but only imperfectly, so that little more can be learned from it. None of the anal veins appear.

Length of fragment, 17 mm.; probable length of wing, 21 mm.

The specimen was found at Petty's Ford on the Little Vermilion river, four miles east of Georgetown, Vermilion Co., Illinois, in the same deposits that furnished *Propteticus infernus* Scudd.

Promylacris (πρὸ, μυλακρίς).

Promylacris Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 34.

Allied to Paromylacris, remarkable like it for its strong convexity, and its stoutness of form, although surpassed by Paromylacris in both features; the frontal shield is about twice as broad as long, sometimes much less than that, and the wings are considerably less than half as long again as their united breadth.

The mediastinal vein, though large and abundantly supplied with veins, terminates at about the middle of the wing; most of the branches fork. The scapular and externomedian veins together occupy the greater part of the wing, the latter terminating below the tip of the wing, but in the different species known they are of varying importance, sometimes the externomedian, at others the scapular, having the predominance; in all, the externomedian branches are long and nearly straight. The internomedian area is narrow, though deep, its veins few and faint. The anal furrow which terminates only a little before the middle of the wing is very deeply impressed and the anal area strongly convex and raised, its veins regular, simple or forked, frequent, and strongly curved.

Indications of legs in one species show that the femora were about as long as half the width of the tegmina, and about as stout as in the modern species of Periplaneta.

This genus is closely allied to Paromylacris, but differs from it strikingly in the much smaller development of the mediastinal area and the course of the scapular vein, which runs through the middle of the wing in Paromylacris but here considerably above it. The costal margin of the wings is much more convex here than in Paromylacris, the pronotal shield not so broad in proportion to its length, though this is variable, and the whole insect not so stout nor so arched.

Three species are known which may be separated as follows:

TABLE OF THE SPECIES OF PROMYLACRIS.

Prothorax distinctly twice as broad as long. Scapular vein much more important than the externomedian . . . . . 1. **P. testudo.**

Prothorax distinctly less than twice as broad as long. Scapular vein not more important than the externomedian.

Prothorax more than half as broad again as long. Scapular vein far less important than the externomedian; anal veins simple . . . . . 2. **P. ovalis.**

Prothorax less than half as broad again as long. Scapular vein not far less important than the externomedian; anal veins mostly forked . . . . . 3. **P. rigida.**

1. **Promylacris testudo** sp. nov.

Pl. 24, fig. 6.

A single excellently preserved specimen showing both obverse and reverse, slightly broken on one side. The form of the body with closed wings is slightly more elongate than in *P. ovalis* and it is a smaller species.

The front wings have a strongly developed well rounded humeral lobe; the costal margin is strongly and regularly convex, while the inner margin is nearly straight, and the apex, so far as can be told, well rounded and not at all produced. The mediastinal area, which is very broad at base, rapidly narrows and terminates at some distance before the middle of the wing and before the anal furrow; the main vein is sinuous in its course, and several of the radiating branches arise from the main stem and nearly all are forked near the margin. The scapular vein, strongly arcuate at the base, is nearly straight but apically arcuate in the opposite sense, running in the middle subparallel to the costal margin, terminating just before the tip of the wing; half a dozen more or less forked branches originate from it mostly in the middle third of the wing, neighboring ones sometimes amalgamated at their bases into a bunch. The externomedian branches occupy all but the upper portion of the tip of the wing, but they are not numerous, though the earliest originate as far or nearly as far as the scapular branches. The internomedian area apparently occupies about half the space from the anal furrow to the tip of the wing, but the veins are few and obscure. The anal furrow is very deeply impressed, the anal area being strongly vaulted, its veins delicate, numerous, straight and parallel; the furrow terminates a little beyond the middle of the wing.

The whole body is considerably arched but the outer fourth of the costal region from the scapular vein to the margin is flattened, a flattening which is shared in no way by the transverse pronotum; the latter is slightly more than twice as broad as long with well arched, slightly appressed front, pronounced though rounded posterior lateral angles, scarcely convex hind margin, and minutely marginate edge; a slight median furrow is indicated, besides two anteriorly converging but distant straight and faint depressions of the surface, and a scarcely perceptible similar V-shaped central impression.

Length of whole body, 23 mm.; of pronotum, 4.75 mm.; width of same, 10.5 mm.; length of wing, 19 mm.; breadth, 8 mm.; breadth of closed wings, 14 mm.

The single specimen known comes from Mazon Creek, Ill., and was received for examination from Dr. J. S. Newberry. It is preserved in the Columbia School of Mines.

2. Promylacris ovalis.

Pl. 28, figs. 1–4.

Promylacris ovale Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 34–45.

This species is represented by a single specimen and its reverse, in a nodule preserving well the front half or more of the body.

The wings have all the tip removed, but the curve of the costal margin is so strong that we may believe only a little less than a third to be gone. This would give to the whole body a rather short obovate form. The front wings have a strongly developed humeral lobe, and a costal margin of considerable convexity; the inner margin appears to be straight but is ill defined. The mediastinal vein originates at the middle of the base of the wing, and after the basal curve the innermost vein runs in a straight course to near the end of the fragment, or to what is apparently near the middle of the wing; most of the branches dichotomize. The scapular vein runs, beyond the base, in a nearly straight course constantly approaching the margin and terminates apparently at the middle of the apical half of the wing; it has three principal branches each of which has several superior branchlets. The externomedian vein is far more important, occupying with numerous branches the entire apex of the wing; the principal branches are three, all of which originate near together far toward the base and dichotomize beyond. The internomedian area is unusually small, reaching apparently not so far toward the tip as the scapular. The anal area is considerably domed, the furrow very deep, considerably curved and ending only a little beyond the basal third of the wing; the veins are numerous, simple, parallel, curved.

Besides the wings, the prothoracic shield and the legs may be seen; the former is regularly arched, about a fourth as high as broad, and twice as broad as long; the latter are seen but vaguely as discolorations through the wings, but closely resemble those of modern cockroaches; whether they are spined or not cannot be said.

Length of fragment of wing, 20 mm.; estimated entire length, 29 mm.; breadth of same, 12 mm.; length of prothoracic shield, 8.5 mm.; breadth of same, 15.5 mm.; length of hind femora (partly estimated), 7 mm.; breadth of same, 1.5 mm.

The single specimen comes from Mazon Creek, Ill., and was sent to me by Mr. W. F. E. Gurley of Danville, Ill.

3. Promylacris rigida sp. nov.

Pl. 28, fig. 6.

A single specimen of which the anterior half is well preserved, including most of the prothoracic shield; but the apical half of the tegmina is broken away, revealing the apical parts of the hind wings somewhat displaced. It is of about the size of *P. ovalis* and resembles it more than it does the other species, but has its prothoracic shield much narrower in proportion to its length, being distinctly less than half as broad again as long, the front margin distinctly though bluntly angulated in the middle, smooth throughout, very gently and uniformly arched and overlapping the wings posteriorly.

The fore wings have a well developed angulate humeral lobe, so that the curve of the prothorax is hardly interrupted in passing to the wing; the costal margin is regularly but not strongly convex, much less convex than in either of the other species, so far as it can be traced. The mediastinal area is triangular, broad at base and rapidly narrowing, terminating at the middle of the wing and slightly beyond the anal furrow; the radiating veins are almost perfectly straight and only the outer ones fork and then but singly and deeply. The scapular vein is almost rigidly straight, stiffly forking beyond its basal fourth, the upper branch again dividing in a similar way near its base, and altogether much resembling a continuation of the mediastinal vein, and covering on the margin only the proximal half of the outer half of the wing. The externomedian vein is similarly rigid in its upper half, but in its lower shows the proximity of the more arcuate internomedian; it divides close to the base into two branches, the upper of which mimics the scapular, forks once before the middle of the wing and probably again beyond, while the lower with a downward curve, scarcely perceptible in the part preserved but no doubt more pronounced beyond, forks a little earlier than the upper branch, each fork again dividing at about the middle of the wing; this vein evidently holds the tip of the wing in its grasp. The internomedian vein, feeble in structure, is gracefully arcuate, but otherwise closely resembles the preceding; for it divides in two branches close to the base, the upper forking just before the middle, the lower sending out two or three arcuate simple or forked veins to the inner margin. The anal furrow is sharp and deep, considerably curved, terminates considerably before the middle of the wing, the anal area well domed, with numerous, parallel, mostly simple and deeply forked veins, the outer ones more arcuate than the others and simple.

The hind wings are exposed apically but not enough to show much of the structure of the wing for want of the vein-attachments. It would appear, however, as if the scapular area were very broad and nearly uniform in the distal half of the wing with relatively few, oblique, moderately distant, straight branches; that the externomedian was not greatly different from what appears on the fore wing; and that the rounded apex was somewhat pointed.

Length of entire fragment as misplaced, 43 mm.; probable length of creature, 37 mm.; length of prothorax, 12.5 mm.; breadth of same, 16.5 mm.; probable length of fore wing, 28 mm.; apparent breadth of same, 16.5 mm.

One specimen from Mazon Creek, received from Mr. R. D. Lacoe under the number 2086ab.

Paromylacris (*πάρος*, *μυλαχρίς*)

Paromylacris Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 35.

An exceedingly broad, rounded, and well arched cockroach, in which the pronotal shield is broadly rounded in front and slightly convex behind, broad in proportion to its length, and the wings not half so long again as their united breadth.

The wings in the only specimens known are imperfectly preserved, but sufficiently to show that the species cannot fall into any described genus of Mylacridae. The mediastinal vein of the upper wing consists of at least seven or eight principal branches originating near the middle of the base of the wing, several of them forking close to the base

and one or two dividing simply beyond the middle; all of them are straight or very slightly curved, the outermost extending far toward the tip of the wing, so as to give this area an unusual preponderance; it occupies indeed about one-fourth of the wing. The scapular vein runs subparallel to the costal margin in a straight course through the middle of the wing to its extreme tip, so that this area and the mediastinal together occupy fully one-half the wing, dividing it between them by a straight and very oblique line; this vein emits four or more long straight branches parallel to the outer mediastinal branches, all of them, with the possible exception of an apical, forking once at or beyond their middle. The externomedian vein begins to fork at about the middle of the wing with dichotomizing branches which, however, do not separate widely and occupy on the margin only the lower half of the broad apex; these branches cannot be called either superior or inferior, as the forks part equally in opposite directions. On the inner margin the internomedian area occupies less space than the anal, and is filled with a number of closely approximate parallel veins scarcely curved and directed obliquely in an opposite sense to those of the mediastinal area. The anal furrow is deeply impressed, broadly curved, and strikes the middle of the inner margin.

The wings are peculiar for their extreme breadth and rounded outline; the costal border is not greatly curved so that the tip of the wing is unusually blunt; they are broadest in the middle, and scarcely twice as long as broad.

Besides the upper wings and the unusually broad pronotal shield, some few unimportant veins of the hind wings occur, but too insignificant to have any special value.

The genus differs from Mylacris, with which it best agrees, in the form of the wing, which does not taper apically but only has the tip rounded off, in the slight obliquity and gentle curve of the anal furrow, in which it resembles Lithomylacris, and very strikingly in the great extent and apical extension of the mediastinal area; in this latter point it recalls somewhat the features of Necymylacris, but only superficially, as the veins all originate and diverge from the base of the wing and show no tendency to simulate the Blattinariae. In its great breadth it is at once distinguishable from Lithomylacris, from which it further differs in the lesser proportionate breadth of the combined mediastinal and scapular areas. Its position in the system is indicated in the table of genera given above.

Two species are known.

Paromylacris rotunda.

Pl. 24, figs. 1, 2.

Paromylacris rotundum Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 35.

The front wing is obovate, scarcely narrower at tip than at base, barely twice as long as broad, the costal border gently and regularly convex, the apex broadly and regularly rounded; transversely also the wings are arched. The base of the wing is injured, but the veins apparently originate in the very middle of the base, with little if any upward curve at starting. The mediastinal area is very large, occupying half of the width of the wing at base, and extending to the middle of the distal third of the wing apically; the numerous veins of this area are traceable to about eight basal shoots, which radiate considerably and not unfrequently fork singly (one is doubly forked), but there is a con-

siderable humeral space altogether devoid of any trace of veins; the humeral angle itself is very prominent, nearly rectangular, the extreme angle rounded. The scapular vein, in the part where it is preserved, which does not include the basal third, is perfectly straight, running through the middle of the wing but slightly nearer the costal than the inner border and slightly oblique, being a very little lower apically, where it terminates at the middle of the tip, than at base; it begins to branch at the end of the basal fourth of the wing, and emits four or perhaps five straight superior branches, the third before the middle of the wing and the fourth at some distance beyond, or at the middle of the outer half of the wing; the third branch consequently not only emits an inferior offshoot, but the latter is again forked to fill the space between the third and fourth scapular branches. The externomedian vein is exactly parallel to and equidistant from the scapular, excepting in the terminal fourth of the wing, where it slightly approaches it; it first divides a little before the middle of the wing, and both these branches, but especially the lower, dichotomize to some extent, but do not diverge widely, so that the inner limits of the externomedian area are not further removed from the tip than those of the scapular. The internomedian vein is obscure, but its branches are scarcely less longitudinal than those of the mediastinal vein and are as closely crowded as those of the externomedian. The anal furrow strikes the middle of the inner margin, but the anal veins are not preserved.

The species is a large one, the largest of this group of Palaeoblattariae excepting *Necymylacris heros*, the length of the wing being 29.5 mm. and its breadth 15 mm., or about as 2 : 1. The specimen is composed of a pronotal shield and the two upper wings, besides a cluster of veins of one of the lower wings which, however, are of no importance; the pronotal shield is nearly perfect, and the wings are related to it in the position of repose, showing the whole animal to have been 38 mm. long from the front of the pronotum to the tip of the fore wings, and 22 mm. in breadth across the middle of the basal half of the wings. A large part of the anterior base of both wings is obscured by poor preservation, the outer half or more of the right wing is wanting, and the left wing lacks all the anal veins and a piece is broken from the apex. The wings may be seen to be transversely wrinkled between some of the veins, but as a general thing they appear to be as smooth as the pronotum, and as if of the same opacity.

The body is strongly arched, the central portion of the pronotal shield being elevated about 4.5 mm. above the margins and regularly rounded in every direction. Fig. 1 shows a cross section taken slightly behind the middle of the pronotum. The pronotum is very large and broad, being 20 mm. broad and about 10 mm. long, the front very broadly rounded, the sides tapering and convex, the hind margin apparently (from the little that can be seen of it) nearly straight but regularly convex; it is rather delicately margined around its lateral and front borders, as shown in both figures. The surface of the pronotum is entirely smooth, excepting in a rather narrow, rather small, subtriangular, central field, its broken apex at the front margin; this area is slightly roughened or scabrous and shows slight signs of a median, longitudinal, very blunt carina which does not appear in the figure.

The specimen was submitted to me by Mr. R. D. Lacoe, in whose collection it bears the number 2026. Both obverse and reverse are preserved. It occurs in an ironstone

nodule 60 x 45 mm. in size, found in the carboniferous beds of Mazon Creek, Grundy Co., Illinois.

Paromylacris ampla sp. nov.

Pl. 23, fig. 7.

The single specimen known is of large size and tolerably well preserved, showing the prothorax (imperfectly), most of the fore wings, and an unimportant part of the hind wings. The body is not so strongly vaulted as in the preceding species, but is considerably more arched than most modern cockroaches. The prothorax is not wholly exposed, being partly still imbedded in the rock (upon the right side of the figure), but it is apparently not quite twice as broad as long and so differs conspicuously from the other species; a triangular space in the posterior middle of the disk is flattened and more or less rugose, while the rest is smooth; there is no sign of margination. In the wings, however, the vaulted area terminates just before the costal edge, leaving a slight horizontal marginal shelf free of arcuation.

The fore wings are a little more than twice as long as broad, the costal area well but not strongly arcuate with a decided humeral angle. The mediastinal area is large, occupying just about one-fourth of the wing, triangular, broad at base, tapering to the tip which is well beyond the middle of the wing; the proximal veins of this area are single, the middle ones deeply and widely forked and the distal third or more is occupied by a compoundly forked vein, all of these radiating with a faint arcuation. The scapular vein is sharply curved at base and beyond runs nearly straight through the middle of the wing and must terminate at or even below the tip; its branches, four or five in number, are either singly forked somewhat beyond their middle or are simple and all are subparallel to the innermost course of the mediastinal vein. The externomedian and internomedian veins have little space wherein to develop and each is simple and single in its basal half and nearly straight except for the necessary basal curve; probably in their outer half they occupy about equal space. The anal furrow is very deep and sharp, and the anal area strongly vaulted, especially in the neighborhood of the former, which is very strongly rounded, nearly bent at base and beyond this at first straight, then gently arcuate, terminating apparently well beyond the middle of the wing; the anal veins, overlooked by the artist, are very numerous, parallel, arcuate, simple, nearly twice as close as the veins of the wing generally.

Parts of the hind wing are also seen beyond the broken fore wings, but show only a multitude of nearly parallel and straight, simple or forked veins.

This species differs from the preceding in its more oval contour, tapering much more at both ends, the less vaulted form, the longer and narrower thorax, and the simpler and weaker construction of the externo- and internomedian veins.

Length of fragment, the hind wing a little thrust beyond its natural position, 45 mm.; probable length, 42 mm.; length of prothorax, 12 mm.; breadth of same, at least 21 mm.; length of fore wing, 31 mm.; breadth of same, 14 mm.

One specimen, Mazon Creek, Ill. Received from Mr. R. D. Lacoe under the number 2088ab.

Lithomylacris pauperata sp. nov.

Pl. 32, fig. 5.

The single specimen represents a fragment of a front wing unfortunately very imperfect, but still sufficiently preserved to show that it is a Lithomylacris, allied to *L. pennsylvanica*, but much larger than it, and certainly distinct from any known species. Not one of the borders is preserved, although in several places the veins are evidently perfect to their tips.

Only one or two of the mediastinal veins can be seen, the outer one long and straight and minutely forked at the tip, with no other offshoots, unless it be at the base, showing the insect to belong to the Mylacridae; within this the forked extremity of another parallel vein can be seen. The scapular vein is perfectly straight as far as what is probably the centre of the wing, and in this basal portion runs down the middle of the wing, thus proving its proper reference to this genus; beyond this it curves very gently and slightly upward; in the fragment it emits four branches, the basal two close together, the others far apart, and the last at the very tip of the piece; the first is simple, the second and third simply forked at no great distance from their origin, and all run in a longitudinally oblique direction, subparallel to the mediastinal vein. The externomedian vein is exactly parallel to the scapular and hardly more distant from it than two adjoining scapular branches from each other; it divides far toward the base, apparently opposite the middle of the anal furrow and just beyond the second branch of the scapular vein, each of its branches again forking opposite the extremity of the anal furrow, and the uppermost branchlet again before the end of the fragment is reached. The internomedian vein is entirely composed of very faintly impressed lines, emits two parallel arcuate branches close together a little nearer the base than the first two branches of the scapular, the first simple, the other forked simply in the middle of its course; and farther apart and from these, two other simple branches, the first opposite the fork of the preceding branch; all of these branches on approaching the border sweep in a more longitudinal course toward it. The anal furrow is not deeply impressed, a little roundly bent beyond the middle, otherwise nearly straight; the anal veins are not preserved, but the furrow appears to strike the inner margin slightly before the middle of the wing. There is no sign of any transverse venation or reticulation.

The breadth of the wing is 12.5 mm.; the length of the fragment 17 mm.; and the presumed length of the wing about 26 mm.; making the breadth to the length as 1 : 2.1. It could hardly have been much longer than that, and would need be very much longer to have had the same proportions as *L. pennsylvanica* to which it is the more nearly allied; the disposition of its nervures is very similar to what we find there, and even if the proportions given are (as they possibly may be) very much out of the way, it is a much larger species than it, being half as broad again. It differs also slightly in neuration, as in the forking of some of the scapular veins, and particularly in the much earlier branching and greater significance of the externomedian vein, which is exceedingly unimportant in *L. pennsylvanica*; the entire disposition of the internomedian veins is also different and they play in this species a much less prominent part than in *L. pennsylvanica*. From the other species it is as widely separated as is its ally.

The specimen was obtained by Mr. R. D. Lacoe, and bears the number 2041 in his collection. It was found at the Port Griffith railway cut near Pittston, Pa., over the E vein and probably over the F vein.

BLATTINARIAE Scudder.

The species to add to this group of carboniferous cockroaches are really more numerous than those from the Mylacridae; but only a few of them are here selected, as the larger part are still unstudied, and there are no new generic types to be found among them, though one, the last described below, belongs to a generic type not before recognized in American rocks.

Etoblattina occidentalis sp. nov.

Pl. 24, fig. 4.

Fore wing long and slender, its greatest width before the middle; the costal margin is rather strongly convex on the basal quarter of the wing, and scarcely at all convex in the middle; the inner margin is gently convex but nearly straight in the middle and the apex is tapering and well rounded. The veins originate at about the middle of the somewhat constricted base, and all curve considerably upward in separating, excepting the anal furrow. The mediastinal vein runs closely parallel to the costal margin, nearly to the middle of the wing, and then curves toward it, terminating only a little before the end of the middle third; it emits a considerable number of equidistant, obliquely curving, simple branches, of which there are about seven in the distal half of the field. The scapular vein runs still more nearly parallel to the costal margin as far as the middle of the wing, and then sweeps very gradually toward it, reaching it only a very little before the tip of the wing; beginning to branch about opposite the end of the anal furrow, it emits about half a dozen subequidistant, simple or simply forked, nearly straight but slightly sinuous branches, which are more longitudinal than those of the preceding area; in the middle of the wing this area and the preceding occupy scarcely two-fifths its width. The externomedian vein divides close by the divarication of the scapular; previous to forking, it is regularly and considerably arcuate; it is now straight at first, but afterwards appears to take on a sinuous course, obscured in the only specimen; it emits three or four principal longitudinal branches which dichotomize somewhat, especially in the apical third of the wing, the nervules curving downward more or less as they approach the margin. The internomedian vein follows closely the course of the externomedian and apparently terminates a little further out than the mediastinal; it emits in the basal half of its course five or six more or less curving, generally simple veins, and doubtless an equal number beyond, but this part is obscured in our fossil. The anal furrow is remarkably pronounced, strongly and regularly arcuate, terminating scarcely beyond the end of the basal third of the wing, and followed in the anal area by seven or eight equidistant, similarly arcuate, simple veins.

The wing is of good size, being 32 mm. long, and 12 mm. broad, or the breadth to the length as 1: 2.7.

A portion of one of the hind wings also shows between the partially opened fore wings, and some few veins of a hind wing appear mixed with those of the right fore wing. Little can be determined from these fragments, for to judge from the first, the hind wing must have been of the same length and very much indeed of the same form as the fore wing, with a similar distribution of veins; while to judge from the latter, in the position it holds, the neuration must have been very much more developed in certain areas.

This insect is more nearly allied to *E. lesquereuxi* than to any other species, but differs from it in many features, such as the equality of the mediastinal area, its more frequent veins, the greater regularity of the scapular branches, and especially the earlier divarication of the externomedian vein, with its consequently larger area, as well as the general disposition of its branches. It is also allied, but not so closely, to *E. mazona*, a smaller species, differing from it in a shorter and more uniform mediastinal area, a different distribution of the veins of the scapular vein, an earlier divarication of the externomedian vein, and, apparently, a much shorter internomedian area.

The specimen is preserved with some of its natural brownish coloring on a light clay-colored stone, and the better half shows a deep impression of the anal area which must have been well vaulted; the other half, showing the upper surface, is not so well preserved. It comes from the old Fair ground at Lawrence, Kansas, and was sent me for examination by Mr. R. D. Lacoe, in whose collection it bears the number 2045ab.

Archimylacris paucinervis sp. nov.

Pl. 23, fig. 5.

The fore wing is long and rather slender, nearly equal, the costal margin, however, somewhat and rather regularly convex (too convex upon the plate), the inner margin straight throughout the greater part of its course, the tip somewhat tapering, a little produced and rounded; the broadest part of the wing is near the middle or a little before it. The mediastinal vein runs in a nearly straight course, very nearly to the end of the second third of the wing, and emits a considerable number (from eight to ten) of mostly forked or doubly forked branches; they differ a little in the two wings, that of the right wing having a fewer number of branches, and they are also more regularly branched; the greatest width of the area is considerably less than one quarter that of the whole wing. The scapular vein runs in a nearly straight line toward the outer margin which it nearly reaches a little before the tip, and then curves a little downward to terminate on this margin a very little before the tip; with its branches it occupies a narrow wedge-shaped area which at the tip of the wing is scarcely more than half its breadth; it emits at the end of the first third of the wing a single branch at a slight angle, which bears all the other branches, excepting a few, mostly simple, short branches which separate from the main stem near its tip upon the upper side, filling the space left unoccupied by short branches beyond the tip of the mediastinal vein; this principal branch reaches the apical margin a little below the apex of the wing and acts differently in the two wings: on the left side it emits two superior branches near together near the end of the second third of the wing, the first simple, the second forked near the tip; on the right wing it forks a

little before the end of the middle third, a very little sooner than on the opposite wing, and each of these branches is again forked, the upper the nearer to the outer margin, and at the same distance from it as the apical fork of the opposite wing. The externomedian vein also differs in a single point very markedly in the two wings; it occupies more space by its earlier division in the left wing, but in neither does it differ much from the preceding in the extent and form of the area which it covers: in the left wing it divides at the end of the basal third of the wing, just beyond the initial forking of the scapular vein; in the right it does not fork until it has reached the middle of the wing; notwithstanding this difference the rest of the area has the same aspect; the lower branch forks a little beyond the middle of the wing, and the upper at about the end of the middle third, the nervules being entirely simple, and this brings the secondary forking of this vein close to its primary forking in the right wing, although far from it in the left. In addition to these peculiarities, this vein possesses another in the presence of a short cross vein running obliquely like an ordinary branch from before the end of the basal fourth of the wing to the internomedian vein, which it strikes at or barely beyond the origin of the second branch of the same. The internomedian vein with its outermost branch strikes the inner margin near the middle of the outer half of the wing, thus occupying on the border considerably more space than either of the preceding two veins; it is considerably arcuate and emits from its lower border three principal veins, the first two simple, the outermost forked, and differing in the two wings; the first vein is sent forth opposite the base of the cross shoot of the preceding vein, the next a little beyond it or a little before the end of the middle third of the wing, while the third originates at a greater distance off, in the middle of the wing opposite the fork of the lower branch of externomedian vein: on the left wing, the inner fork is simple, the outer forked again in the middle of its course, or it might be said that the main stem had four principal and all simple branches; in the right wing, both forks subdivide, the inner halfway, the outer at much less than halfway, to the margin. The anal furrow is very arcuate near the base and at this part deeply impressed, beyond nearly straight and hardly impressed, running very obliquely and terminating on the inner margin not very far before the middle of the wing; the anal veins count about eight at the margin; they are much simpler on the right than on the left wing, having in the latter three which fork and one of these an interpolated one which connects with those on either side by an oblique cross vein; while most of those on the right wing are simple, one forking close to the base, another near the middle; they are all considerably arcuate. The differences therefore between the two wings are considerable in the minuter details, though important only in the first branching of the externomedian vein, which strangely does not affect the subsequent offshoots of the same.

The hind wing of each side is also present to a considerable extent. More perhaps can be said of its form than in almost any other paleozoic cockroach hitherto described. The wing, except in lacking altogether any convexity in its straight costal margin until the narrowing of the wing begins toward the apex, closely resembles in form the fore wing; it is of just about the same length and breadth also, a point which appears to distinguish the ancient from the modern types; so far as we know, the hind wings of the former gradually taper apically to a well and very regularly rounded apex. It should be

particularly noticed that its form as well as the character of its main venation bears a striking resemblance to the wings of Dictyoneura and its allies. The only well marked difference is, perhaps, in the costal area where its alliance to the fore wing of the Palaeoblattariae appears. Owing to the obliteration of the attachments of the main veins, very great uncertainty must remain as to the normal veins to which any of the longitudinal nervures belong; the mediastinal vein, however, is clearly marked; it runs in very close proximity to the margin, not farther from it than the other nervures are separated from each other; it terminates just about as far from the tip of the wing as in the front wing and emits a large number of necessarily short but very oblique and generally forked branches. Following it are at least five principal nervures, all of which seem to belong to preanal areas, but any two or more of which may belong to the same principal vein, so far as anything can be stated from this specimen. The first, counting from the mediastinal vein, is forked at a point exactly similar to the basal forking of the scapular vein of the fore wing and in a similar way, and hence may be presumed to be that vein; this basal forking of the presumed scapular vein can only be seen in the left wing, where the upper branch is simple; the lower branch, however, is seen distinctly in both wings to fork exactly opposite the second forking of the lower scapular branch of the upper wing; the forks, however, act differently in the two hind wings: on the left side they both fork, the upper halfway, the lower three-quarters way to the margin; on the right side, the lower is simple, while the upper forks before the middle and its lower branch forks again halfway on its course; the number of nervules reaching the margin is thus the same and they cover the same narrow space, the lowermost striking the tip. Judging from the analogy of the upper wing, the next two nervures, which are exactly alike in the two hind wings, belong to the externomedian vein, in which case they repeat almost exactly the characteristics of the same vein in the upper wing of the left (but not of the right) side, forking first (to judge from the gradual approximation of the two nervures baseward) at or a little before the end of the middle third of the wing, the lower fork again branching at some distance beyond the middle of the wing, and the upper halfway between this and the tip. Below these are, first a forked nervure and then a simple one, both of which probably belong to the internomedian vein, but do not resemble the same part in the upper wing; the forked vein forks as far from the margin as (but of course further from the tip than) the upper externomedian branch: in the left wing it is simply branched; in the right it sends a similar offshoot from both sides of the stem, *i. e.*, it divides into three at the same point; all these nervures are very long and straight with a slight downward sweep as they approach the margin, especially in the upper part of the wing; they are about as distant from each other as in the upper wing but, particularly, the lower ones are less oblique; on the left wing there is also another fragment of a simple vein, as far below the lowest mentioned as the latter is from its predecessor and trending slightly toward it baseward; it probably also belongs to the internomedian vein.

Besides the wings, a part of the pronotal shield is present, and the limits of the abdomen are partly marked by a depression. The former is nearly semicircular, somewhat broader than long, very regularly rounded in front, the sides very slightly divergent behind the middle; the posterior edge appears to be scarcely convex; a little to the outside of the middle of either lateral half is a slight rounded furrow or depression, less curved

than the margin and passing faintly around the front close to the margin; a subcircular flat depression nearly a third as broad as the shield rests upon its posterior margin; the edge of the shield is very delicately marginate.

The abdomen is remarkably slender like that of *Etoblattina? insignis*, as mentioned in my memoir on Palaeozoic cockroaches, being scarcely more than a third as broad as this pronotal shield, and extending beyond the middle of the outer half of the closed wings; a few incisures marking segments can be seen, but the whole contour is exceedingly vague.

The insect is of pretty large size, much larger indeed than the other species of the genus, the fore wings measuring 30.5 mm. long and 10 mm. broad, the proportion of the breadth to the length being as 1 : 3, making it also slenderer than the other species. The length of the whole body from front of pronotal shield to tip of abdomen is 29 mm., the pronotum itself being 6 mm. long and 7.75 mm. broad and the abdomen about 3 mm. broad. The specimen is unusually perfect, both fore wings being nearly complete, as well as the apical half of both hind wings, and most of the pronotal shield; the latter is in its natural position in relation to the partly expanded wings, but the direct connection with it is broken; the abdomen is only traced by a depression in one stone and a rough ridge in the reverse. The front wings are covered throughout with a delicate but readily traceable reticulation, consisting of very irregular polygonal cells in all the areas but the mediastinal, internomedian, and anal, where the nervules are united by frequent uncertain or wavy cross veins into subquadrate cells, usually square in the mediastinal area and broader than long in the others; in the latter, too, and especially in the internomedian area, they tend next the margin of the wing to change to the irregular polygonal reticulation.

This species differs decidedly from either of the species of this genus hitherto known. It is larger and has a much slenderer wing than either. The scapular area is of considerably less extent, the vein far less branched, and the mode in which its branches are distributed very different; its internomedian area is also much more restricted than in the others.

The specimen occurs in an ironstone nodule found at Morris, Grundy Co., Illinois, and was discovered by Mr. J. C. Carr of that place, through whose kindness I have been able to examine it. It is now in Mr. R. D. Lacoe's collection with the number 2011.

It may be added that this specimen is of particular interest as having the wings more completely preserved than in any other paleozoic cockroach yet known, and offers even a better example than *Anthracoblattina sopita*[1] for comparison of the neuration of opposite wings; it leads us to hope that future discoveries may enable us by correlating these differences to determine the distinction between individual and specific characters among ancient cockroaches,—a question we are hardly yet in a position to discuss.

Oryctoblattina occidua.

Pl. 24, fig. 3.

Oryctoblattina occidua Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 37.

The single specimen known lies in the half of a nodule, and shows the larger part of

[1] *Cf.* Scudder, Palaeozoic Cockroaches, Mem. Bost. Soc. Nat. Hist., III, 89 (1879). Geinitz, Blattinen unter. Dyas v. Weissig, Nova, acta Leop-Carol. Akad., XLI, 423 (1880).

the two front wings, slightly parted and vague indications of the thorax and possibly of the legs. The prothorax is quadrate, pinched transversely in the middle to a definite ridge, which is probably accidental. The legs, if the elevations near their position may be taken to indicate their appearance, must have been very short and tolerably slender.

The front wings are rather slender, the tip well rounded and slightly produced, the costal margin slightly shouldered at the base, beyond nearly straight in the basal half, apparently sloping downward beyond, the inner margin apparently broadly rounded but the basal half not clearly indicated in the specimen. The veins appear to originate from the middle of the upper half of the base of the wing, and have scarcely the least basal arcuation. The mediastinal vein runs at but slight distance from and nearly parallel to the costal border, in the outer half or more constantly but very gradually approaching it, emitting numerous oblique generally simple branches; the vein terminates in the middle of the outer half of the wing, and shows no such peculiarities at its tip as characterize the European species. The scapular vein also is not so peculiar as in *O. reticulata;* it runs in near proximity and parallel to the mediastinal vein, but there is the same slight bend in its course at the base of the principal branch; the mass of the branches, which are much fewer than in *O. reticulata*, do not arise as there from a vein emitted abruptly from near the base of the second branch, to which they are inferior. but from the principal branch itself, to which they are superior. Less can be said about the other veins, as they are obscured throughout most of their course, but the internomedian vein terminates at about the end of the middle third of the wing and has only few branches; and the externomedian branches all terminate on the inner margin.

The wing is 19 mm. long, and 7 mm. broad, the breadth to the length being as 1 : 2.7. It is reticulated minutely, as in the European species, and is interesting as being the second species of the genus known, and as illustrating once more the close relationship of the insect fauna of Europe and America in carboniferous times. It is a smaller and slenderer species than the European.

It comes from the beds of Mazon Creek, Illinois, and was sent to me by Mr. R. D. Lacoe, in whose collection it bears the number 2039.

EXPLANATION OF PLATES.

PLATE 23.

Figs. 1–4 by Mrs. Katherine Peirson Ramsay; fig. 5 by J. S. Kingsley; figs. 6–7 by J. H. Emerton.

Fig. 1. *Promylacris ovalis*, ½ cast.
" 2. *Promylacris ovalis*, ½ side view.
" 3. *Promylacris ovalis*, ½ cross section of prothorax in middle.
" 4. *Promylacris ovalis*, ½ relief.
" 5. *Archimylacris paucinervis*. ½
" 6. *Promylacris rigida*. ½
" 7. *Paromylacris ampla*. ½

PLATE 24.

Figs. 1–2 by J. S. Kingsley; figs. 3–4 by Mrs. Katherine Peirson Ramsay; fig. 5 by S. H. Scudder; fig. 6 by J. Henry Blake.

Fig. 1. *Paromylacris rotunda;* ½ cross section of thorax in middle.
" 2. *Paromylacris rotunda*. ½
" 3. *Oryctoblattina occidua*. ½
" 4. *Etoblattina occidentalis*. ½
" 5. *Lithomylacris pauperata*. ½
" 6. *Promylacris testudo*. ½

New Carboniferous Myriapoda from Illinois.

THE publication of my paper on Archipolypoda, eight years ago, in which a considerable number of new types of American carboniferous Myriapoda were described, has so stimulated search in this country that, thanks to the kindness of many friends and particularly of the indefatigable Mr. R. D. Lacoe, there has since passed under my eyes a much greater number of specimens than I had then seen, and as they contain not a few additional and some remarkable forms, as well as throw more light upon the old, it has seemed well to bring them together in a systematic way, and to present some tables by which they may be distinguished, when sufficiently perfect. Accordingly there are here published such as have been found at Mazon Creek and vicinity leaving for a future paper several new forms which have been found in the sigillarian stumps of Nova Scotia. The sources from which the specimens were received are in all cases indicated, and the paper concludes with a summary list of known American species of palaeozoic Myriapoda.

TABLE OF THE ORDERS OF PALEOZOIC MYRIAPODA.

Each of the principal body segments composed of a single dorsal and single ventral plate, each of the latter with a pair of legs. Body usually unarmed.

Head apparently formed of a single segment. Dorsal plates of body supporting clusters of needle-like spines on serially ranged tubercles. Legs stout and fleshy . . . . . **Protosyngnatha.**

Head apparently formed of two or more segments. Dorsal plates of body sometimes furnished with lateral expansions but otherwise unarmed. Legs slender and horny . . . . . **Chilopoda.**

Each of the principal body segments composed of a single, but more or less distinctly divided dorsal plate and a pair of ventral plates, each of the latter with a pair of legs. Body generally armed with spines or tubercles serially arranged . . . . . **Archipolypoda.**

Only the Chilopoda and Archipolypoda will be considered in the present paper, as I have nothing to add concerning Palaeocampa, the sole representative of the Protosyngnatha.

Order CHILOPODA Latreille.

It has not been supposed that this group of myriapods reached further back than the Jura or even than the tertiaries, for its only claim to recognition in the secondary rocks

is Münster's *Geophilus proavus*, which is very probably not even a myriapod. The nearest proof of the appearance of the order in paleozoic deposits is in the possible judgment of some that Palaeocampa (which bears somewhat the same relation to Chilopoda that Euphoberia does to Diplopoda) should be taken as one of them. No one has made such a claim, and should one do so he would have to recognize in Palaeocampa a highly organized and very aberrant type. But not only do specimens received in recent years from Mr. R. D. Lacoe and Mr. W. F. E. Gurley, but especially from the former, show that Eileticus was nearly allied to the Scolopendridae, and either belonged to the Chilopoda, or was an archaic type to be looked upon as its forerunner; but a single specimen from Mr. Lacoe has also revealed still a second type of chilopodiform character, an ancient type of Scutigeridae. These discoveries carry the chilopodiform line much further back than it was believed it existed, and so far as the record goes renders nugatory much of Dr. Packard's reasoning concerning the greater antiquity of the Diplopoda (Proc. Amer. Phil. Soc. xxi, 206–207), though the occurrence of the diplopodan line in the Scottish devonian should not be overlooked.

The indications of the presence of heavy armature in some of these chilopodiform carboniferous myriapods, together with the character of the segments, and the features by which they show kinship to their contemporaries rather than their descendants, lead me to believe that when more is known about them, they may prove to form an archaic type distinguishable as a whole from the later chilopods, as the Archipolypoda from the diplopods; but the incompleteness of our knowledge of their structure leads me to wait for further light and meanwhile to place them in distinct families separable from their evident successors by trenchant characters.

Gerascutigeridae fam. nov.

Body relatively short. Head no broader than the body. Dorsal scutes of the same number as the segments and corresponding to them, much broader than long, with no evidence whatever of mediodorsal stomata. Coxæ extending beyond the sides of the body, followed by femora of excessive length.

Latzelia gen. nov.

Of the general aspect of Scutigera but differing essentially at every point. The head is vaguely preserved, and none of its appendages can be seen. The body is broadest in the middle, and tapers gradually and about equally in each direction, giving it a rounded fusiform appearance, and the head does not interfere in the least with this outline, so that it is scarcely half as wide as the middle of the body. The segments, to which the dorsal scutes exactly correspond (so different from Scutigera), are subequal in length, and apparently nineteen in number, certainly not more than one or two segments away from that; in the middle of the body where widest they are about four times broader than long; both front and hind margins are entire, showing no trace of a recess to favor the presence of stomata. The legs are nowhere completely preserved, but are apparently unequal in length and slender, as in Scutigera, and at shortest more than half as long as the body, apparently very much as in Scutigera; but their composition is very different; the coxae

are even more prominent than in Scutigera and notwithstanding the more robust body project much further beyond the sides; but in addition the femora are of excessive length and slenderness, slenderer than the coxae and half as long again as the width of the very broad body, and taper from base to apex; to judge by appearances these two members constituted the larger, instead of as in Scutigera the smaller, part of the leg, but this cannot be asserted; probably however the tibiae and the (multiarticulate?) tarsi together were no longer than the femora.

The genus is named in honor of Dr. Robert Latzel of Vienna who has so much advanced our knowledge of the Myriapoda.

Latzelia primordialis sp. nov.

Pl. 30, fig. 3.

The single specimen is found in a small nodule which at the two extremities cuts off the appendages, but offers no hindrance to the full expanse of the members laterally, though their full length cannot yet be seen. The main features have been described above under the family and genus, both of which have their source in this single specimen. No part of the antennae is preserved. The body segments, however, show a peculiar structure; not only are the front and hind margins entire and transverse, permitting no opening to the position of the mediodorsal stomata found in Scutigera, but most of the segments (all where not obscure) show a distinct, marked and sharp mediodorsal carina extending the whole length of each segment, but somewhat obscure posteriorly over just about so much of the dorsal shield as in Scutigera is emarginate for the stomatal opening; and on either side of this carina, all the segments, but especially the median ones, show a pair of diverging sulci, twice as distant posteriorly as anteriorly, crossing the entire segment, and posteriorly as far apart as the length of the segment; sometimes also showing faint traces of continuing upon the segment next posterior. The body itself is slightly arched transversely.

The legs are similarly constructed, but the median ones are evidently stouter than those at the extremities, to a slight degree. Both coxae and femora show the median half transversely arched, while the sides show nothing of the sort, or sometimes interiorly, next the transverse arching, a broad longitudinal sulcus, all giving the appearance of a depressed leg with a median rounded longitudinal ridge, very common in the Archipolypoda.

Length of body, 22.5 mm.; breadth in middle, 4.5 mm.; length of coxae in middle of body, 2.3 mm.; of femora in same, 6.5 mm.; breadth of same coxae, 0.9 mm.; breadth of same femora at base, 0.7 mm.; at tip, 0.5 mm.

Mazon Creek. Mr. R. D. Lacoe, No. 1837ab.

EOSCOLOPENDRIDAE fam. nov.

Head evidently formed of two principal segments, but these much more closely fused, separated only by sulcations or blind sutures. Body segments numerous and similar, each bearing a single pair of legs and having a single dorsal and ventral plate, the former

sometimes furnished with tubercles. Much remains to be learned of the structure of all the animals here brought together.

Eileticus Scudder.

As already remarked, the discovery of better remains proves that this genus finds its place better here than in the Archipolypoda. The imperfection of the only specimen known when this genus was founded led to several errors of interpretation which may now be corrected. The head was not composed, properly speaking, of a single apparent segment, but of two, a larger anterior and smaller posterior segment, each with its independent vaulting, the hinder with a pair of foot jaws arising from its posterior portion; but the two segments are not separated as in modern chilopods by a distinct suture, but only by a broad and shallow transverse sulcus from the meeting of the two arches. Nor do any of the segments bear, as was judged from the appearance of the non-attached anterior members of the original specimen, more than a single pair of legs, but very little can be said about them. The form of the segments and their tuberculation would appear to be subject to some variation. No complete specimens have been found, nor any in which more than thirteen or fourteen segments behind the head are preserved.

Eileticus anthracinus.

Pl. 30, fig. 5.

Eileticus anthracinus Scudd., Mem. Bost. Soc. Nat. Hist., III, 179 (1882).

Another specimen of this species, far more perfect than the first and with its reverse, has been found at Mazon Creek, and sent me by Mr. Lacoe, in whose collection it bears the number 1835ab. It exhibits the dorsal surface of the anterior extremity, very likely about half the body, but fragmentary and without appendages, of an animal of about the same size as the original. It shows about thirteen segments besides the head. The latter, broken in front, shows a flattened globular mass of smooth texture, with a faint transverse median impression separating independently though faintly arched anterior and posterior portions; a longitudinal median impression of similar depth crosses both but is not accompanied by an independent arching of the head in the other sense; from the middle of the posterior margin of either lateral half of the hinder section of the head arises a decided, cornuous, tapering, forward and downward reaching, independent arched member, plainly representing the foot-jaws.

The segments of the body are sub-equal in length, but enlarge in breadth in passing from the first behind the head where it is slightly narrower than the head to about the sixth segment, beyond which they are about equal; each, when perfectly preserved, shows a transverse, marginal, strong and abrupt, rounded sulcation at its anterior edge, the margins of which are prominent, and the hinder at a much higher level than the anterior or proper margin of the segment. The surface of the segment is smooth and uniform, except that at the extreme lateral margins, as in the original specimen, are seen more or less distinctly small tubercular bosses serially arranged. The best preserved segments appear to be a little more than twice as wide as long.

Length of fragment if extended, 48 mm.; breadth of head, 6.4 mm.; greatest breadth of body, 8 mm.

Dilelicus aequalis sp. nov.

Pl. 30, figs. 6–9.

A second species seems to be indicated by a couple of specimens from the same locality sent me by Mr. Lacoe under the numbers 1836ab and 1836cd, both shown in obverse and reverse. The better of these (figs. 6–8) is a remarkably well-preserved but very fragmentary specimen, showing the dorsal view of the front part of the body consisting of the head and eleven segments. The head closely resembles that of the specimen of the last species just described, but has more accentuated sulcations both longitudinal and transverse, and the foot-jaws are more pronounced even than there; as there, also, the front of the head is broken, but on the reverse, what appear to be the first two joints of an enormous antenna project laterally, in which case the antennae are broader at the base than the very base of the foot-jaws.

The segments of the body have a smooth texture, and the same transverse stepped sulcation that occurs in the preceding, but with less prominent edges; still it differs from it markedly in that the segments are almost absolutely uniform in size; they have a lateral depressed and horizontal flange with a rounded edge, while the main body is strongly arched, and the lateral flange bears such slight tuberculations as can be seen; without this flange the body is slightly narrower than the head; with it a little wider; the segments without the flange are a little more than three times as broad as long.

Length of fragment, 26.5 mm.; of one of the principal segments, 2.3 mm.; breadth without flange, 7.25 mm.; with it, 10 mm.; breadth of head, 7.75 mm.

The other specimen (fig. 9) is similarly preserved but more imperfect, one whole side being broken, and the head far less complete. There is little to be said about it, but its transverse arching shows that it was nearly cylindrical; and the posterior as well, but not to the same extent, as the anterior margin of the segments has a stepped transverse sulcation. The head is far less perfect, but as far as it goes shows precisely the same features; the body segments are thirteen in number, and show by their apparent inequality in length that there was greater or less power of extension by elastic intersegmental membranes. No one of the segments is perfect, so that the proportions cannot be stated, and only one side is approximately perfect, and that does not preserve the lateral flanges; but enough remains to show that the specimen by its equality of breadth belongs to this rather than to the preceding species.

Length, 50 mm.; breadth of head, 7 mm.

PALÆNARTHRUS gen. nov. (*πάλαι, ἔναρθρος*)

A genus evidently very different from anything before known from the carboniferous rocks, but unfortunately known only by a single specimen, which from its incompleteness leaves much to be desired. That it was a scolopendriform chilopod or archaic type of chilopod is evident from the flattened rectangular plates of which the dorsal surface of

the body is composed, each accompanied by a single pair of legs. What is peculiar about it, is not only its tapering form anteriorly but its great attenuation at this extremity, indicating apparently a remarkably small head followed by a slender neck of at least two elongated segments, which do not appear to be pedigerous; these neck-segments are fully twice as long as broad, and not only do the segments behind them taper as they approach them, but the anterior of these two is the smaller and narrower and not a fourth nor probably a sixth as broad as the broadest segments of the body. The legs are poorly preserved, about as long as the breadth of the body (relatively longer in front) and apparently have very prominent coxae, as in other carboniferous myriapods.

Palenarthrus impressus sp. nov.

Pl. 30, fig. 4.

The single specimen probably represents nearly the whole animal, though neither end is shown; it is hardly probable that anything more than the head is wanting at the anterior extremity, but posteriorly an indefinite number of segments. There are twenty-three segments in all. The first two behind the head are slender and twice as long as broad, the third subquadrate, the four or five succeeding broader than long, of subequal length, but increasing breadth in passing backward; thereafter they appear to be of the same size, about twice as broad as long and rectangular, the front outer angle sometimes a little produced. The first two elongated segments show a slight median carina; the fourth and succeeding ones on either side a laterodorsal series of large circular depressions next the anterior edge.

Length of fragment, 46 mm.; breadth of first body segment, 1 mm.; of seventh, 5 mm.; length of legs, 3 mm.

Mazon Creek. Mr. R. D. Lacoe, No. 1821ab.

ILYODES gen. nov. (ἰλυώδης)

I venture to propose this name for some obscure forms in the hope of stimulating further search for more perfect specimens to elucidate their structure. One of them is plainly chilopodiform, though very different from anything we know; there is certainly but a single pair of legs to each segment, though the line of separation of the segments is obscured by the curious transverse sculpture of the dorsal plates; but we are aided in our determination by the presence of serial tubercles. These latter, or their reverses, also occur on the taenioid body of a second form which has no legs preserved, and which is provided with such a multitude of short transverse segments that it would seem impossible that it could have possessed more than a single pair of legs to each; it reminds us somewhat of Geophilus. The only points these have in common are that they are composed of a large number of similar transverse segments each bearing a single pair of legs and furnished with serial rows of tubercles.

Ilyodes divisa sp. nov.

Pl. 30, fig. 1.

The single specimen referred here is a straight fragment composed of fourteen simi-

lar segments shown apparently upon a side view, the lower edge of the segments irregularly broken so that their exact proportions can hardly be told, though some of the legs are partly preserved; there is no indication, however, that the segments varied in size, and all were probably about half as broad again as long. They show two features: first, each segment is composed of a series of equal and similar slight transverse ridges, about eight in number; these ridges are more or less tremulous or sinuous, and slightly uneven, presenting faintly a beaded appearance; second, there is a lateral series, one to a segment, of rather large tubercular bosses, irregularly rounded, upon the very front margin of the segments. The legs are very obscure, and their jointing, as shown in the figure, altogether uncertain; as far as preserved, which may very well be not to their extremity, they are shorter than the breadth of the body.

Length of fragment, 48 mm.; apparent breadth, 5.5 mm.; average length of segments, 3.6 mm.; diameter of tubercles, 1.5 mm.

Mazon Creek, Ill. Mr. R. D. Lacoe, No. 1830ab.

Ilyodes elongata sp. nov.

Pl. 30, fig. 2.

The single specimen which represents this species is formed of two masses, one L-shaped and overlying the other which is U-shaped; evidently both belonged to the same individual, and their connection could have been traced had the stone been broken open more favorably. The division line between the segments cannot be everywhere traced from the obscurity of the preservation on the stone, but there are present evidently at least one hundred and sixty-six segments, which differed apparently not over a sixth in width and that little perhaps due to a twist in the body as laid down; they differed, it would appear, as little in length, being almost uniformly about three and a half times as broad as long; they show no sculpture whatever, but an obscure series of small depressions in the middle of the segment next the suture; if the creature where these so appear were lying on its side, these depressions would hold precisely the position of the tubercles in *I. divisa* and may represent the cast of weaker tubercles.

Length of whole if extended, 65 + 96=161 mm.; breadth, 3.5–4 mm.

Mazon Creek, Ill. Mr. R. D. Lacoe, No. 1829ab.

Order ARCHIPOLYPODA Scudder.

It is in this order that the principal additions in specific forms are to be found, and they are mainly in the family Euphoberidae from which, as already stated, the genus Eileticus must be removed. It is, moreover, not impossible that future discovery of more perfect specimens may show that Amynilyspes should be regarded as one of the Diplopoda (allied to the Glomeridae) rather than as a member of the Archipolypoda; but the apparent necessity of ventral plates of excessive width and the known armature of the dorsal plates render it proper to retain it in the Archipolypoda until its structure is better known, or at any rate until undoubted Diplopoda are found at so early a period.

Family EUPHOBERIDAE Scudder.

ACANTHERPESTES Meek and Worthen.

Acantherpestes major.

Acantherpestes major Scudd., Mem. Bost. Soc. Nat. Hist., III, 150 (1882).

Mr. R. D. Lacoe has sent me several new specimens of this species, which appears to be not uncommon at Mazon Creek, but they add little or nothing to what has previously been published. The best specimen (No. 1801de) exhibits about twenty-four segments of the body, neither end of which appears. The spines are nowhere well preserved, but the legs are partly shown at each extremity, and seem to be unusually broad, flattened, and crowded, with no sign of any median carina; although the specimen is not of the largest size, the fragment measuring about 15 cm. in length, and at most 17 mm. in breadth, the legs are 1.5 mm. broad in the middle.

Another specimen of this species, from Mazon Creek, sent me by Mr. W. F. E. Gurley, consists of a fragment from the middle of the body, of twelve segments preserved upon a side view, the spines of the subdorsal series showing finely, but no trace of legs. The body is curled slightly backward, as is most common in the specimens so far found, and the segments are 20 mm. high and in the middle 7 mm. long on an average. The spines are about 15 mm. long, the apical 4.5 mm. concerned in the furcation; the forks are deeper than usual, and the boss on which they are seated is 2 mm. high.

Finally, a smaller specimen, presumably of this species, likewise from the middle of the body and about 11 cm. long, from Mazon Creek, is in the museum of Columbia College, the opportunity of examining which I owe to Dr. J. S. Newberry. It is also preserved upon the side, shows no legs, and only indications of the subdorsal spines, the pleurodorsal indicated by abraded bosses. It contains nothing to add to the structural peculiarities of the species. It is made up of sixteen segments which are about 14 mm. in height.

Acantherpestes inequalis sp. nov.

Pl. 25, figs. 2, 4.

Two specimens of gigantic myriapods have been sent me, one by Mr. R. D. Lacoe, the other by Mr. J. C. Carr, but now in the possession of the former, which are clearly distinct from anything hitherto known. Although very differently preserved and showing very different characters, they seem to belong together since they agree in the one feature of the inequality of the tines of the forked spines.

One of them (fig. 2), received from Mr. Carr, but now numbered 1819ab, in Mr. Lacoe's collection, is a fragment of the anterior part of the body preserved to show a completely dorsal view. The head is transversely oval, but shows no structure; about a dozen segments are preserved, showing that the body tapered forward, and that the first segment was much narrower than the head, unless, as is very probable, the latter is unnaturally crushed; the first few segments are very short and broad, but posteriorly they enlarge and lengthen, so as to be only about three times as broad as long, and present a somewhat coarse granular structure. The armature, however, is the most interesting

feature; the lateral spines extending on either side are fully as long as the width of the body, sometimes considerably longer, and are remarkable for the great length and inequality of the forks, at least from the fifth segment backward, the longer fork being posterior and diverging from the other and sometimes as long as the stem of the spine itself; there are, besides, basal thorns both anterior and posterior, of varying length but the anterior usually the longer and sometimes very long and slender. The subdorsal row of spines is clearly indicated by bosses (or pits in the obverse) upon most of the segments; the pleurodorsal series is not so clear, but appears to be indicated, posteriorly, by the extremities of apparently simple spines which protrude laterally beyond the sides of the body between the lateral spines. There is besides, protruding from the posterior extremity of the sixth segment, just as I described it in *A. major*, a long slender stiff rod, here thrust sidewise and thrown a little forward, longer than the width of the body.

The length of the specimen is 63 mm.

The second specimen (fig. 4), received from Mr. Lacoe, under the number 1819cd, shows only the posterior part of the animal and in an entirely different position. It is preserved upon a side view, and shows about eighteen segments though only ten are here figured. Here only the dorsal spines are shown, and they differ remarkably from the others in being almost boot-shaped, the longer posterior fork being almost the only one developed; this is inclined at a strong angle with the stem, and is nearly as long as it; moreover, the whole is short and stumpy, less than half as long as the width of the tapering body, excepting on the posterior segments, and the anterior fork is only indicated by a slight projection at the heel of the boot; as, however, they agree with those of the lateral row in the other specimen (and not seen here) in the unequal length of the forks, which mainly distinguishes either from *A. major*, they are placed together until further light is obtained from other specimens. The legs are fairly well preserved, are not closely crowded, slender, with only slight sign here and there of a median carination, taper very regularly beyond the middle to a point, the last joint the shortest, the preceding three subequal and only a little longer; at the hinder extremity of the body they about equal in length the width of the body, but a dozen joints away, while of the same length, they do not more than equal half the breadth of the body. The length of the fragment is 93 mm.; the legs are about 9 mm. long. The spines of the other rows do not plainly appear, but their place is here and there obscurely indicated.

It remains to be seen whether we are here dealing with two species, but the complete and striking inequality in the forks of the spines will not allow us to look on them as belonging to *A. major*, to which at first sight they have a striking resemblance. Neither of these specimens indicates quite so large a species as that, though much stouter than any species of Euphoberia.

Mazon Creek, Ill.

Euphoberia Meek and Worthen.

I subjoin a table of the species of this genus known up to the present time in North America.

TABLE OF THE SPECIES OF EUPHOBERIA.

Body stout.
- Very large species, with large bristling spines having large basal spinules.
  - Largest of all, with spines like *Acanth. major* but more deeply forked, not very divergent and with basal spinules both anterior and posterior . . . . . **E. hystricosa.**
  - Smaller with more delicate spines and only posterior basal spinules . . . . . **E. horrida.**
- Ordinary sized species with more delicate compound spines, the basal spinules not so highly developed.
  - Spines long; spinules highly developed.
    - Surface sculpture delicate; body largest on segments 12–18, tapering gradually each way **E. armigera.**
    - Surface sculpture coarse; great contrast in elevation of subsegments . . . . . **E. granosa.**
  - Spines either very short with highly developed spinules, or long with very slightly developed spinules.
    - Body with broadly rounded hinder extremity.
      - Hinder half of body much smaller than front half, the change sudden . . . **E. carri.**
      - Hinder half of body gradually tapering and not strikingly different in the two halves **E. cuspidata.**
    - Body with hinder extremity abruptly tapering to a blunt point . . . . . **E. flabellata.**
- Ordinary sized species with simple spines . . . . . **E. spinulosa.**

Body slender and long drawn out.
- Nearly uniform throughout.
  - Segments at least half as broad again as long. . . . . **E. simplex.**
  - Segments hardly broader than long . . . . . **E. tracta.**
- Delicately tapering so as to be less than half as broad at tail as in front . . . . . **E. anguilla.**

Euphoberia hystricosa sp. nov.

Pl. 25, figs. 1, 3.

Unfortunately but a small fragment of the single known specimen is preserved, but this is so characteristic as to leave no doubt of its relations. Seven adjoining segments from near the middle of the body appear on the small nodule, all of the same size and showing a dorsal aspect. The segments are about two and a half times broader than long, and the shorter anterior portion is considerably elevated and bears near its outer limit a boss which represents the base of a spine belonging to the subdorsal series; the spines themselves are broken off, but those of one of the lateral series appear, and are exceedingly large and formidable. They are very stout and very long, nearly as long as the entire breadth of the body and apparently depressed, forked a little beyond the middle, the forks only slightly divergent and subequal, lying in the same plane as the body of the spine, the anterior the longer, stouter and blunter, and scarcely bent forward from a continuation of the basal part of the spine. Besides this, there is at the base, apparently clearly separated in all instances from the great spine, but in close proximity to it, a slender spinule anterior and another posterior also lying in the same plane, but showing no signs of depression.

Length of the fragment, 46 mm.; of the single segments, 5.5 mm.; breadth of same, 14 mm.; length of spines, 13 mm.; width at base, 1.75 mm.; length of spinules, 3 mm.

The species closely resembles in general effect *Acantherpestes major*, but there are no pleurodorsal series of spines, and therefore it cannot fall into that genus. No species of Euphoberia at all resembles it, or can compare with it in size, excepting the European *E. ferox*, which differs entirely in the shape of the spines at base, and in lacking the anterior ridge upon which the subdorsal spines are mounted. The spines of this species closely resemble those of *Acantherpestes major*, and agree with them in size, but they differ in the great depth of the apical fork, as well as in minor points.

The nodule comes from Mazon Creek, Ill., and was sent to me for study by Mr. R. D. Lacoe, in whose collection it bears the number 1802ab.

Euphoberia armigera.

Pl. 26, figs. 2, 4, 8; pl. 27, fig. 3.

Euphoberia armigera Meek and Worthen, Amer. Journ. Sc., (2), XLVI, 25–26 (1868).

A specimen received from Mr. R. D. Lacoe (No. 1804cd, of his collection, fig. 3) from the Mazon Creek nodules, is nearly complete but appears to lack both extremities; thirty-five segments are preserved, showing a dorsal view of a sinuous body, the lateral spines of one side nearly complete, together with a few of the other side in front; these are slender, gently curved, and do not appear to show any spinules whatever, though there are here and there possible indications of them, not shown in the figure; the spines are, however, poorly preserved, and the absence of spinules may be looked upon as merely the accident of preservation. The body is not prominently ridged, and is flattened by preservation; no rug sity of the surface is noticeable. The anterior half is of nearly uniform size, scarcely tapering in front, the segments about twice as broad as long; the posterior half tapers very regularly to less than half the size of the middle, the segments shortening a little. The spines are about half as long as the greatest width of the body. No legs are visible.

Length of specimen, 75 mm.; greatest breadth, 4.25 mm.

Besides this I have seen nearly a dozen specimens, most of them received from Mr. R. D. Lacoe, but others from Mr. W. F. E. Gurley, Prof. J. S. Newberry and Mr. F. T. Bliss. None of these require special mention, excepting one of those received from Mr. Lacoe under the number 1804kl (fig. 8). This is a portion of the hinder end of the body of unusually large size, and containing about twenty-nine segments; one remarkable thing is the slight degree to which it tapers, the diminution in size being altogether confined to the last ten segments, half the diameter being lost in that distance. The segments are nearly twice as high as long, have the subsegments well distinguished, and show the texture of the surface, which appears to have been finely pitted with transversely arranged somewhat transverse punctures, shown as too circular in the figure (fig. 2). Along the middle line of the body and also next the under edge appear some perhaps wholly foreign textures, one of which is represented still further enlarged in fig. 4, which are serially arranged and may be mere mineral fillings of spine-scars. Nearly all the subdorsal spines are seen; they are well heeled, rather slender, arcuate, and pointed, considerably longer than the segments. Very many of the legs can be seen, and these are unusually short and stout and incurved; the enlarged figures show well their division into joints at different parts of the body, from which it would appear that the second joint was not elongated, and on this account I have very much doubted whether this specimen should not be separated from the others as a distinct species.

Length of fragment, 108 mm.

Euphoberia granosa.

Pl. 26, figs. 5, 6; pl. 28, fig. 2.

Euphoberia granosa Scudd., Mem. Bost. Soc. Nat. Hist., III, 168 (1882).

To this species I refer several specimens seen since the originals were described, which

are remarkable for their coarse sculpture, inequality of the subsegments, and general form of the segments, although some at least of them have spines which differ somewhat from those of the previous specimens, perhaps due, however, to their belonging to different longitudinal series.

One of them which is here figured (fig. 6) shows only about a dozen or fifteen segments from near the anterior end of the body, and is considerably larger than the largest specimens hitherto known. It is preserved upon the side and the spines seen at one edge are evidently those of the subdorsal series. The segments are about three times as broad as long, but the flattening of the body largely conceals the evident previous inequality of the subsegments; the surface is very coarsely granular (fig. 5). The spines are rather stout, very much shorter than the segments, curved backward, and show no sign of any anterior fine basal spinule, but instead a distant basal posterior spinule of similar coarseness as the main spine, but very low; these are not well shown on the plate as they can only be well made out by shifting the point of view. The legs are slender and nearly as long as the width of the body. The ventral plates are seen in part and are normal.

Length of fragment, 58 mm.; breadth, 10 mm.

The specimen comes from Mazon Creek, Ill., and was received from Mr. R. D. Lacoe, in whose collection it bears the number 1805ij.

Another specimen, also received from Mr. Lacoe and bearing the number 1805mn, is of nearly equal size, preserved in a sinuate curve, lying upon its side, and showing similar parts; it is much more complete, showing almost the entire length of the animal, the head possibly and a portion of the tail certainly absent. About thirty-eight segments are present. It is of nearly uniform size throughout, except that it is slightly larger over a rather broad space in the middle, the front third about equal, and the posterior part considerably smaller, giving a contour unlike any before met with. The segments have the usual proportions and distinct heavy sculpture of the species, the granulations, however, somewhat exceptionally unequal and distant. Here also the spines of the subdorsal series are much as in the specimen last described, but do not show so clearly the posterior basal spinule, and also show no sign of any anterior one. The legs are slender, extended at full length, and evidently longer than the width of the body in advance of the widest part.

Length of fragment if extended, 95 mm.; greatest width, 9.5 mm.

Two other specimens also received from Mr. Lacoe, Nos. 1805kl and 1805h, of smaller size, also belong here; they show nothing peculiar excepting that each at its hinder extremity, which in one case is perfect, shows that the subdorsal spines at this extremity of the body were apparently simple but remarkably stout, short, and blunt; they are only twice as high as their basal breadth.

To this species I also refer doubtfully a specimen from Mazon Creek (fig. 2) sent me by Mr. Gurley, showing about twenty-four segments preserved on a side view with some of the legs. No spines are present and only a few places are at all characteristic. It is in any case a small specimen, measuring but 40 mm. in length, and 1.75 mm. in diameter. It is nearly equal throughout, tapering only a little toward the tail. The legs are 2 mm. long.

Euphoberia carri.

Euphoberia carri Scudd., Mem. Bost. Soc. Nat. Hist., III, 171 (1882).

A single additional specimen has come to hand, a large fragment containing all but the two ends of the body, stretched in a bent line, presenting a dorsal view of about thirty segments. As in the specimens already described, there is not only considerable diversity in the general size of the front and hinder half of the body, the front half being nearly double the width of the hinder, but the change is relatively rapid, falling upon a few segments near the middle, though this is not so pronounced as in those previously described. The segments are about three times as broad as long, with a slightly greater relative breadth on the front than on the hinder half of the body. The anterior spiniferous half of each segment is heavily ridged, while the posterior is nearly flat, though this condition is somewhat effaced by crushing in the middle of the body.

Only the basal bosses of the subdorsal series of spines can be seen and these are near together, but in many cases obscure. The lateral series is tolerably complete throughout upon both sides and shows these spines to have been tolerably stout, sharply pointed, a little curved and scarcely so long as the segments; where suitably turned they show an angle near the middle of the front contour, which is all that appears of a spinule, probably broken off; but a very considerable, straight, slender needle arises from behind the base of the main spine, in situations favorable for it to be seen, almost half as long as the main spine. No legs are preserved. The whole surface of the body is finely and evenly granulate.

Length of fragment, 63 mm.; greatest breadth, 9 mm.; least breadth, 5.5 mm.; length of spines, 2.5 mm.

Mazon Creek, Illinois. Museum of Columbia School of Mines, communicated by Dr. J. S. Newberry.

Euphoberia cuspidata sp. nov.

Pl. 26, figs. 3, 7.

A single specimen only is known of this species, the head end of which is obscure, and the other extremity broken off. About seventeen segments are shown, preserved in a straight line upon a side view. The body tapers forward a little on the three or four front segments and to a somewhat similar degree behind the twelfth or thirteenth segment, but the portion preserved is very nearly uniform. The surface is granulose as in *E. granosa*. The head is exceedingly vague, but appears to be large, to have a rounded front, and to droop. The body segments appear to be slightly selliform by the ridging of the anterior edge, and they bear, apparently on the posterior half of the segments, a row of superior spines (presumably on both sides). By the fracture of the stone, these spines are very obscure, but they appear to be short, stout and double, having an anterior erect prong, not higher than one-fifth of the thickness of the body, and an oblique, backward directed, posterior prong a little shorter and subtriangular. The legs are a little longer than the thickness of the body, laminate, the flat surface set obliquely (the edge being forward and outward), of nearly equal width until near the pointed tip, when they taper rapidly, the joints indistinguishable in this specimen.

Length of specimen, 36 mm.; breadth, 2.5 mm.; length of legs, 4 mm.; their basal breadth, 0.75 mm.

The species is distinguishable from the others by its short, double spines, its more than usually equal form, and by the shape of the segments, which are only about half as broad again as long. It seems to be most nearly related to *E. carri*, but altogether lacks the sudden attenuation of that species in the middle of the body. It is not unlike *E. granosa*, with which the texture of the body and the length of the segments agree, but the spines are very different and there is no such sudden contrast in elevation between the subsegments. The figure represents the legs as much too slender.

The specimen was sent me for study by Mr. R. D. Lacoe, in whose collection it bears the number 1814ab. It comes from Mazon Creek, Illinois.

Euphoberia spinulosa sp. nov.

Pl. 26, fig. 1; pl. 27, figs. 1, 4, 5; pl. 28, figs. 7, 8.

The single specimen upon which this species was first recognized is a nearly complete animal lying partly coiled on its side (Pl. 26, fig. 1) and showing the legs and a few spines. It is somewhat stout, tapering only a little in its posterior half and still less anteriorly, the specimen composed of about thirty-seven segments; the segments consist apparently (for they are crushed and obscure) of an anterior, shorter, elevated, domed portion, bearing spines, and a longer, lower and flat portion. In some places the ventral plates, two to each of the dorsal subsegments, can be seen, every alternate one bearing legs; that is, every ventral segment is broken into two,—an anterior larger, pediferous, and a posterior apodal subsegment, the division indicated by a slightly lower level of the apodal half. The main segments of the body are from two or two and a half to a little less than three times as broad as long, and the spines (of which only a few of the subdorsal ones can be seen) are perfectly simple, straight, slender and tapering, scarcely half as long as the width of the body. The legs are slender and tapering, slightly more than half as long as the width of the body. The head is completely obscured, being mingled with the legs toward which it is coiled, but the posterior end of the body is distinct, with a rounded rectangular hinder edge where in the last segment it suddenly comes to an end.

Estimated length of the specimen if uncoiled, 94 mm.; breadth in the middle, 6 mm.; at posterior extremity, 3.5 mm.; length of legs, 3.5 mm.; of spines, 2.75 mm.

The specimen lies on a piece of blue limestone forming the roof shale over the lower coal seam at Braidwood, Illinois, and was received for study from Mr. R. D. Lacoe, in whose collection it bears the number 1820a.

The species as based upon this specimen seems to differ from all I have seen in the simple character and delicacy of the spines, which have no basal thorn; the anterior elevated portion of the segments is also narrower in proportion to the rest than usual.

About a dozen other specimens later examined agree pretty well in their general characteristics with *E. granosa*, and in the form of the segments with *E. carri*, but differ from them, as from nearly all others, in the character of the armature, the spines being long and slender and entirely without basal or other secondary spinules, and are there-

fore regarded as belonging here. In this respect they agree apparently with *E. brownii* of England, with which indeed they may possibly prove identical, though they grow to a much larger size than any British specimens I have seen.

The most perfect example (figs. 4, 5) is preserved upon a side view, each half with a distinct and partial coil. The lateral termination of the dorsal and ventral scutes is visible throughout; and the large transverse spiracles are readily seen next the outer base of the legs, in the middle of the segments or with the anterior edge in the middle of the segments. The head shows little beyond its outline, and appears little larger than the segment behind it, with an inferior tapering prolongation; from a little below the middle of the front springs an antenna whose total length a little exceeds that of the head, interrupted in the middle, but apparently as a whole consisting of ten or eleven joints which are oval and subequal, more than half as long again as broad, and slightly larger apically than basally, the terminal joint smaller than the others. The body is largest in the middle and subequal in more than the middle half, tapering about equally and very gently at each extremity. As thus preserved, upon a side view, showing only one half of their surface, the dorsal scutes are of about equal length and breadth, and appear to be composed of a larger anterior and shorter but higher posterior section, upon the latter of which the straight, simple, delicate spines shorter than the segments are mounted. The legs are exceptionally short and stout, and blunt tipped, hardly tapering; they are about as long as the segments.

Length if uncoiled, 84 mm.; height in middle, 4.5 mm.; length of segments, 2.75 mm.; of spines, 2 mm.; of legs, 2.5 mm.

Mazon Creek, Ill. Mr. R. D. Lacoe, No. 1820cd.

One of the largest specimens belonging to this species (Pl. 27, fig. 1) is also preserved upon a side view coiled into a semicircle. The ventral scutes here look as if formed of a collection of transverse straps, three or four to each scute, with a finely granular surface, but the dorsal scutes are less perfectly preserved, though when clear differ in no way from those of the typical specimen; the spines at the front end of the body are, however, relatively coarser and the legs seem relatively longer. The specimen measures 130 mm. in length, and 9 mm. in middle height, tapering as in the preceding toward either end but perhaps over a longer region. The specimen is in the collection of Columbia College, whence I received it through the courtesy of Prof. J. S. Newberry.

Another specimen (Pl. 28, fig. 8) shows the same view of the front half of an animal stretched out straight, and is interesting principally from its preserving one of the antennae attached to the middle of the front of the head (fig. 7); this is apparently not complete, a little shorter than the head and composed of about seven joints, some of them obscure, but where best preserved cylindrical and half as long again as broad; it tapers a little. The distinction between the anterior and posterior sections of the body-segments is greater than usual, and where the surface is clearly seen it is distinctly and rather coarsely granulate; the stigmata are very distinct, and as in the previous specimens, but the legs are vague. It comes from Mazon Creek, Ill., and bears the number 1820ef, in Mr. Lacoe's collection.

Other specimens, some received from Mr. Lacoe, others from Mr. Gurley, do not appear to add much to what these have told us. One, however, No. 1820gh, of Mr. Lacoe,

is a young specimen, and here the spines appear to be erect with no backward sweep and to be nearly or quite as long as the width of the body; only a dozen segments are preserved and the specimen, very imperfect, is only 17 mm. long and 1.75 mm. in diameter.

Euphoberia simplex sp. nov.

Pl. 27, figs. 2, 6, 7.

A couple of specimens of spined Archipolypoda differ so much from the others I have described, that they seem better separated from them. By their slender forms they agree best with the two species which follow, while in their size and armature they agree better with most of those that precede.

The first and best specimen (fig. 2) shows the whole of a myriapod extended with a gently sinuate curve; it presents a lateral aspect. The head is a little larger than the immediately succeeding segment, but is very poorly preserved, and shows no appendages. The segments of the body are thirty-seven in number, increase rather rapidly in size on the anterior six, the size then attained being retained up to the third or fourth before the hinder end when they taper similarly, the last segment being bluntly rounded and about as large as the head; excepting where tapering, the segments are a little less than twice as broad as long, and are separable into a shorter anterior and a longer and more elevated posterior subsegment, at the anterior part of the latter of which the spines are seated. These are arranged as usual in the genus, and the subdorsal series consists of nearly simple, short and pointed, arcuate spines, barely or not half so long as the segments, with a posterior basal spinule arising faintly from a sort of heel to the spine, often very inconspicuous and not shown on the plate; in texture, the upper surface appears to be finely granulated, while the lower plates show a fine punctuation, the punctae transversely elongated. The legs are very well preserved, in many places showing well the division into joints and the median longitudinal carina; the second joint is usually just about as long as the subequal remaining three; they are strongly compressed laterally, and most of the tapering occurs on the apical joint; their surface is smooth but not polished.

Length, 91 mm.; breadth in middle, 4.5 mm.; length of middle legs, 3.75 mm.; of longest spines, 2 mm.

Mazon Creek, Ill. Mr. R. D. Lacoe, No. 1812ab.

A second less perfect but interesting specimen from the same place (fig. 7) is similarly preserved on the stone but with the hinder end drooping and possibly not quite complete. The head is better preserved than in the preceding specimen, much larger than the immediately succeeding segments, well rounded, a little longer than broad, and shows a few obscure antennal joints (fig. 6); they are only three or four in number, subequal in length, but narrowing slightly, and all together not more than half as long as the head. The body is subequal almost thoughout, scarcely showing any signs of tapering in front, while the specimen is too imperfect behind to determine that point. There are about thirty-three segments which are only about half as broad again as long. No spines can be certainly made out, but nearly all the legs are preserved, though ob-

scurely, and where preserved do not always show the longitudinal carina on adjacent segments; legs are found at entirely equal intervals up to the head, but the state of preservation of this general region does not permit further statement; the legs are a little shorter than the width of the body.

Length, 51 mm.; breadth, 2.75 mm.; length of legs, 2.4 mm.; of antennae 1.75 mm.

Mazon Creek, Ill. Mr. W. F. E. Gurley.

The species is peculiar for its slender form and relatively long segments combined with short sharply pointed spines. In general appearance, except for its slenderness and general form, it reminds one most of *E. carri*.

Euphoberia tracta sp. nov.

Pl. 28, figs. 1, 4–6.

The first specimen seen (fig. 1) is only tolerably well preserved, shows both obverse and reverse, and exhibits a lateral view of the greater part of the creature from the head backward over about thirty-four segments. The body is gently curved, the back convex, and near the head end more strongly arched, exceedingly long and slender, of nearly uniform size throughout, there being no sign of tapering anteriorly, and it is barely perceptible on the posterior fourth preserved. The head is larger than the segments behind, and droops considerably, the larger size being indicated by the amount of this droop, since the top of the head is continuous with the upper surface of the body; it is well rounded in front, but nothing can be made of any appendages. Unfortunately also none of the spines are preserved, and the only indication of their presence is in occasional pits, especially at the anterior end. The segments are unusually long, bringing the legs of succeeding pairs much farther apart than usual. Excepting in the anterior part of the body, they are of about equal length and breadth,— a feature which at once distinguishes this species from any other; the anterior part of the segments is narrowly ridged, and across the middle is a less prominent and more rounded transverse elevation dividing each segment into two equal subsegments. This has not been made to appear in the figure. In places where best preserved the surface of the segments shows a very delicate granulation. The legs are, as stated, far apart, a little longer than the width of the narrow body, slender, tapering regularly and pointed. They show slight or no signs of any unusual basal expansion, and their joints are indistinguishable.

Length of body, 46 mm.; width of same, 1.6 mm.; length of legs, 2.5 mm.; their basal width, 0.3 mm.

The specimen comes from Mazon Creek, Ill., and is numbered 1838ab, in the collection of Mr. R. D. Lacoe, from whom I received it.

The second specimen (fig. 5) is in a similar state of preservation, and was not seen until the preceding was described. It shows both obverse and reverse and represents the lateral view of the entire animal, if the tail end is complete, and though difficult to determine by its obscurity in certain parts, appears to be composed of about thirty-five segments behind the head. The body is long and slender, tapering very inconsiderably in its posterior half. The head appears to be still partly buried in the stone, and consequently does not show its size or form, but it evidently droops very much below the lower level of

the body. No spines are preserved anywhere, and only slight indications of their insertion are apparent. The segments are obscure throughout, excepting near the head, and therefore could not be enumerated, but for the legs. As in the previous specimen, they appear to be generally of about equal length and breadth, but next the head they are broader than long. The division into two parts, as shown in the other specimen, is obscured here, excepting next the head where it is identical. The legs are as in the other specimen, except in being possibly a little longer and in showing some basal expansion.

Length of body (if straightened), 40 mm.; middle width of same, 1.5 mm.; length of legs, 2.8 mm.; their basal width, 0.3 mm.

The specimen comes from the same place, and bears the number 1838cd, in Mr. Lacoe's collection.

A third specimen (fig. 4) seen, together with the following, after the preceding descriptions had been written, shows a lateral view of a slightly arcuate animal, nearly the whole of which is preserved, although almost wholly destitute of appendages. The body is thus seen to be of nearly equal size thoughout, scarcely tapering on the first three or four segments and in the posterior fourth, composed of forty-two subquadrate segments, besides the head; the latter is a little broader and larger than the segment behind, well rounded but shows no appendages. The segments are everywhere similar, about a third or a fourth broader than long and show a division into two subsegments by a median or antemedian tranverse sulcation and a slight difference in elevation of the two subsegments, the anterior being slightly the higher; the signs of spines are slight, but occasionally a simple, arcuate, very short spinule rises above the dorsal outline. The legs are almost entirely obliterated, but a few at either extremity show that they are as long as the width of the body or even longer, and very slender.

Length of body (if straightened), 45 mm.; middle width of same, 1.6 mm.; anterior width, 1.2 mm.; length of anterior legs, 1.5 mm.

The specimen comes from Mazon Creek, Ill., and was received from Mr. R. D. Lacoe, in whose collection it bears the number 1838gh.

A fourth specimen (fig. 6) shows a scarcely arcuate body of a specimen slightly larger than the last but not so fully preserved, both ends being lost. About thirty-six segments are seen, slightly broader than long, but in general they show very little structure; it would seem, however, as if besides the median sulcation between the subsegments, each of the latter had its own submedian transverse sulcation much sharper and slighter than the other; the surface was apparently smooth; no signs of spines appear except a lateral series indicated at one extremity by very deep circular pits at one margin, presumably the anterior, of each segment. Legs are seen all along the lower margin of the body, though by no means always perfect; when complete they are somewhat longer than the width of the body, very slender, and delicately tapering.

Length of the fragment, 52 mm.; breadth in middle, 2 mm.

This specimen also comes from Mazon Creek, Ill., and from Mr. Lacoe, and bears the number 1838ef.

A fifth specimen is a curious one; it represents apparently a single specimen, but it is bent abruptly upon itself twice, so as to be broken or apparently broken into three

nearly equal parts, lying one above the other, the upper and lower parallel, the middle and longer piece, really the anterior third, a little oblique, crossing one end of one of the others. The great length and slenderness of the specimen with the subquadrate form of the segments leave no room to doubt that it belongs here, but it shows very little, for the head is unprovided with appendages, and only slight indications of spines, quite as in the other specimens, appear. Some parts display the legs fairly well, showing that they were very slender and tapering, considerably longer than the breadth of their segments. The body appears to have been largest near the base of the anterior third and to have tapered very slightly in either direction, the hinder end quite blunt. If it is not broken, but the disconnected parts are united beneath the present exposed surface of the stone, its total length must have been fully a decimeter; if broken and all parts are seen it would still be 9 centimetres long, while its greatest breadth is 2.5 mm., and at the hinder extremity 1.75 mm.

The specimen comes from Mazon Creek, Ill., and was received from Mr. R. D. Lacoe, in whose collection it bears the number 1838ij.

Another specimen has been received from Mr. W. F. E. Gurley from the same locality, but is exceedingly imperfect; it is apparently a young specimen, being if uncoiled only 40 mm. long. It is too poor to measure the breadth at any point, but it appears to have been equally slender with the others.

The species is remarkable for its nearly uniform and slender body, the great length of the segments as compared with the width of the body, the slenderness of the legs, and the unusual distance apart of consecutive pairs.

Euphoberia sp.

Mr. R. D. Lacoe has sent me a straight fragment of a Euphoberia, composed of about fifteen or sixteen similar and equal segments from what is apparently about the middle of the body, but which is too imperfectly preserved to determine the species, though it perhaps represents *E. tracta* or *E. simplex*. It would not be worth mentioning but for the appearance it presents of being covered above with a mat of flowing hairs, here appressed to the surface. The segments are about half as broad again as long, and their surface finely granulate. The total length of the fragment is 26 mm.; it comes from Mazon Creek, Ill., and is marked 1839a, by Mr. Lacoe.

Euphoberia anguilla.

Pl. 28, fig. 3.

Euphoberia anguilla Scudd., Mem. Bost. Soc. Nat. Hist., III, 177, Pl. 12 fig. 20 (1882).

An additional specimen (fig. 3) has been found, but it adds little to our previous meagre knowledge. It is nearly complete, however, though the head end is altogether obscure. It lies in an arcuate position upon the stone, the dorsal parts convex, and the legs drooping from the under surface. The head is very obscure, but apparently agrees with what is seen in the original specimen, and, as there, no appendages are visible. The body is largest in the middle of the anterior half and tapers very gently in each direction, the tail being about half as wide as the broadest portion, which is not so nar-

rowly confined as in the specimen before found; the segments vary in their proportions very much as in the original, though they appear to be relatively shorter next the hinder end. The legs are poorly preserved, but can be seen through all but the front end of the body to be shorter than the width of the body, especially in its widest portion, and to be rather stout, slightly tapering and blunt tipped. No spines are clearly seen, but their presence on the subdorsal region is indicated by obscure marks, which in no way differ from the few seen in the type. The specimen is about 53 mm. long and comes from Mazon Creek, Morris, Ill., where it was obtained by Mr. F. T. Bliss. It bears the number 131 in my collection.

Still another specimen of what appears to be this species has been sent me by Mr. R. D. Lacoe. Both faces of the nodule show the specimen about equally well or rather ill. It is indeed so faint that no attempt has been made to have it drawn. Like the original it is preserved on a dorsal view in a curved position, the front two-thirds pretty strongly bowed, the hinder third bent at right angles to the part in front and curved or roundly bent in the same sense. The whole animal appears to be preserved and it differs from the type only in tapering a little more rapidly and in having the posterior extremity extended almost to a point. If extended its length would be about 35 mm.; its breadth at greatest behind the head, 2.5 mm.; and in the middle of the body, 1.75 mm. The segments are too indistinct in many parts of the body to be counted, so that the total number cannot be compared with that of the type, but just behind the head the segments appear to be just about twice as broad as long, and in the middle of the hinder half they are proportionally but little longer than in front. The tapering of the body is almost entirely confined to the hinder half, and at the extreme tip the body is less than 0.25 mm. broad. Nothing can be told from this specimen any more than from the first known concerning the structure of the spines or legs, unless certain marks at the sides of this, near the middle, indicate legs; these would then be exceedingly slender and fully as long as the width of the body.

Mazon Creek, Ill., nodules. No. 1807cd.

Family Archiulidae Scudder.

Archiulus Scudder.

Several species are now known to me from North America, besides those here described which are somewhat problematical from the nature of their entombment. Others from the sigillarian stumps of Nova Scotia will be described on another occasion.

Archiulus? glomeratus sp. nov.

Pl. 29, figs. 2, 3.

A closely coiled, moderately large galley-worm (fig. 2) is doubtfully referred to this genus, though much larger than any heretofore found, because its well preserved segments show no sign of any division into frustra and no indication of spines or any longitudinal series of prominences. Eighteen or nineteen segments are preserved, all but

four or five of them very well,—at least the dorsal scutes. These consist of simple plates with well rounded lower edges which apparently extend beyond the lateral limits of the body proper (to judge by the transverse curving ridges generally seen above their termination), about twice as broad as their greatest (superior) length, with indications of some thickening of the anterior and posterior margins, preceded by a more or less distinct and extensive transverse furrow. No definite signs of the ventral scutes can be seen and they are apparently covered by the presumed lateral expansion of the dorsal scutes which on a side view would conceal them. The legs are seen in several places, but too obscurely and intermingled to say more of them than that they appear to be certainly very stout and long and longitudinally ridged. Neither extremity of the body is seen and there is no apparent sign of any tapering.

Length of specimen if uncoiled, 43 mm.; length of single segments, 2.5 mm.; breadth of same, 5.5 mm.; breadth of legs near middle, 0.75 mm.

The specimen occurs in a nodule from Mazon Creek, Ill., and was collected by Mr. J. C. Carr, to whom I owe the opportunity of studying it. It has since been secured by Mr. Lacoe, in whose collection it bears the number 1823ab.

Here also I am inclined to place a similarly coiled but much smaller specimen (fig. 3) from the same locality, preserved in a small nodule sent me by Mr. R. D. Lacoe and bearing the number 1823cd. It is rather obscure and shows little more than the dorsal scutes seen on a side view with no sign of spines or legs or frustra. About forty-two segments are represented and all are of nearly the same size and in their relative proportions closely resemble the larger specimen before described. The texture of the surface is very finely granular, almost smooth. If uncoiled, the creature (imperfect) would be about 36 mm. long; its width is 2.5 mm.

Archiulus? sp.

Pl. 29, fig. 1.

A species of myriapod apparently belonging to this genus but very obscurely preserved on black shale amid a mass of vegetable débris, especially fern leaves, was sent me by Mr. R. D. Lacoe from the Malden Mine, Kittanning coal, Kanawha Co., W. Va., and bears in his collection the number 1810a. It represents an openly coiled body, apparently nearly complete as to length, about 85 mm. long, composed of from forty to fifty segments very obscurely defined. The body is largest at what is taken to be the head end, tapers rapidly to the head and very gradually to the tail end at the edge of the stone. Generally speaking the segments are about twice or a little more than twice as broad as long, and the surface is generally covered with an exceedingly delicate and uniform striation transverse to the body, and in some places at the head end also longitudinally; although not detected elsewhere on the stone, it is suspected to be extraneous to the fossil.

Xylobius Dawson.

This genus, peculiar for the frustrate dorsal scutes of the body, originally described from the sigillarian stumps of Nova Scotia, is now somewhat widely known, occurring

as it does in Great Britain and, as will be seen by the following descriptions, from the carboniferous deposits of Mazon Creek, Ill.

Xylobius frustulentus sp. nov.

Pl 29, figs. 4–6.

This is a small species and represented by specimens closely resembling in general appearance our smaller species of Iulus from temperate regions. One is preserved on a side view (fig. 5), strongly curved like a fish hook, and is apparently complete, though both ends are rather obscure. It is long and very slender, almost equal, tapering scarcely in the least at either end and composed of alternately longer and shorter segments, as shown in fig. 6; the number cannot be determined from the obscurity of parts of the body, but they would appear to number all told more than fifty. The larger ones are about three, the smaller about four times as broad as long. The frustra are the same on both, separated from each other by delicate incised lines, which are a little sinuous as well as slightly oblique; they are very narrow, narrower than on any known species, being eight or ten times longer than broad. The legs are delicate, slender, cylindrical, a little shorter than the width of the body, the joints indeterminate.

Length of the body, 33 mm.; width of same, 1.75 mm.; length of legs, 1.45 mm.

This specimen, which comes from Mazon Creek, was received from Mr. R. D. Lacoe, and is numbered 1842ab, in his cabinet.

The second specimen (fig. 4), sent me after the preceding description was prepared, is similarly preserved in a somewhat semicircular curve; as there, both ends are obscure and probably neither of them is complete. It is long and slender, nearly equal but slightly tapering on the posterior half and anterior fifth, and not so clearly composed as there of alternate longer and shorter segments, the shorter, in the greater part of the body at least, appearing more as mere interspaces and showing no sign of division into frustra, which are perfectly evident and exactly as in the other specimen in the shorter segments. The shorter segments have more the appearance of being originally formed of a less dense integument than the larger ones, and as being here folded or compressed; in this way only can the structure of the two specimens — which agree in all other respects — be made to accord sufficiently to consider them the same species. The number of segments, counting only the larger ones, are twenty-nine, and they have the same form and proportions as in the other specimens, with exactly similar frustra. The legs are of similar delicacy and length, but, as there, with indeterminate joints.

Length of body, 31 mm.; width of same, 2.2 mm.; length of legs, 1.75 mm.

This specimen was obtained at Mazon Creek and was received from Mr. J. C. Carr, but is now in Mr. Lacoe's collection under the number 1842cd.

Still another specimen from the same place has been more recently sent me by Mr. W. F. E. Gurley. It is in better condition than the others, curled much as they, and shows all but the very head and hinder extremity; probably not half a dozen segments are lacking; forty-one appear. These are alternately longer and shorter, one about one-half longer than the other, each with its own independent arching; the whole of a pair of segments as thus constituted when seen on a side view, is about two-thirds as long

as high and is traversed longitudinally by fine lines breaking it up into frustra of exceeding slenderness, perhaps eight or ten times longer than broad. The legs are exceedingly slender, finely tapering to a delicate point, and about as long as the width of the body.

Length if extended, 44 mm.; breadth, 2.25 mm.

The species is mainly peculiar for the exceedingly narrow frustra, but also for the alternation of longer and shorter segments which appears wherever two adjoining segments are clearly defined. It bears certain resemblances to the interesting *Kampecaris forfarensis* Page, so carefully described and figured by Mr. Peach of the Geological Survey of Scotland; more indeed than to any myriapod yet described from this continent. But the smaller segments are much less important than there, the feet are much slenderer and Mr. Peach makes no mention whatever of anything akin to frustra. Our own species is represented by specimens far less perfect than his and does not admit of a really satisfactory comparison.

Xylobius mazonus.

Pl. 29, figs. 7–11.

Xylobius mazonus Scudd., Zittel, Handb. d. Palaeont., I, II, 730, fig. 902b (1885).

The first specimen of this species which came under my notice was received from Mr. Lacoe with the number 1809ab, and was interesting from being the first myriapod seen from Mazon Creek in which the segments were broken into frustra, and much larger than other species of the genus, found heretofore only in the sigillarian stumps of Nova Scotia. This specimen (fig. 7) is preserved on a side view, and shows a gently arched body, bent a little behind the head; excepting near the extremities, which taper considerably for half a dozen segments (fig. 9), the body is of nearly uniform width; it is complete, and composed of numerous very short segments, obscure in places but apparently numbering about fifty. The form of the body and its general appearance at first recall the commoner Euphoberiae of these beds, but a closer examination soon shows considerable differences. Spines are wanting, the extremely short and broad segments extend the whole width of the body and are broken regularly into frustra; the legs are very delicate and not very long, and the head is not larger than the segment behind it. The segments are about six times as broad as long and the frustra unusually narrow, being fully four times as long (equal to the width of the segment) as broad, as shown in the enlarged sketch (fig. 8) of two or three adjoining segments a little in front of the middle of the body. The legs are very slender, and apparently cylindrical, but their full length shows only at the hinder extremity of the body where they equal its diminished diameter. The specimen is 61 mm. long; 5.5 mm. broad in the middle; 2.75 mm. broad at the head end; the longest legs at the posterior end are about 4 mm. long.

The second specimen (figs. 10–11) is more interesting on account of its perfection. It was also received from Mr. Lacoe and bears the number 1809cd, in his collection. It also shows a side view, gently arched, especially toward the head end, which is apparently complete though obscure, while the hinder end is partly concealed under stone,

and may extend beyond the limits of the enclosing nodule. The body is of nearly uniform width, but tapers forward a very little on the first eight or nine segments and toward the posterior end. The segments preserved are forty in number, and are of about the same proportion as in the other specimen. From its better preservation, however, it shows clearly, what the other shows but vaguely, the exact form of the segments; the body was plainly cylindrical or nearly so, and the anterior and posterior border of each segment was thickened to form together an elevated, more or less rounded band, together a little more than twice as broad as the intermediate, lower and more flattened interspace covering the most of the segment; the anterior thickening occupies twice as much of the band as the posterior; the sutures of the frustra cross the entire segment, including the band, both anteriorly and posteriorly; the frustra are separated and marked off by slight raised lines, running with a slight obliquity and are of the same proportion as in the other specimen. The head shows no peculiarities, as it merely ends in a bluntly rounded curve, with no visible appendages and is altogether very obscure. The legs are delicate, slender, cylindrical, pointed, and unless in the proportionate lengths of the joints, which cannot be determined, in all respects like those of a modern Iulus; they are nearly as long as the width of the body.

This specimen is also of special interest from the fact that its excellent preservation ensures seeing any spines which might project beyond the body, and which do not exist. On one of the stones, however, there may be seen on most of the segments a minute wart or tubercle centrally placed, forming a pleurodorsal row apparently about midway between the middle of the sides and the middle of the back, similar therefore to some obscure indications of the same sort on other species of Xylobius. It is interesting also [illegible]howing clearly the lower edges of some of the dorsal shields next the present lower edge of the fossil, showing that here the ventral scutes must be much narrower than the dorsal.

The length of the specimen is 45 mm.; its breadth in the middle, 4.5 mm.; at the head end, 4 mm.; length of legs, 4 mm.; their greatest breadth, 0.08 mm.

Both the specimens are from Mazon Creek, Ill.

The species differs from any known by its much larger size, the narrowness of its frustra, and the strap-like character of its sutural prominences, which do not fall gradually to the level of the lower part of the segment forming a more or less striking selliform curve, but abruptly.

EXPLANATION OF THE PLATES.

PLATE 25.

Figs. 1 and 3 are by Mrs. Katherine Peirson Ramsay; figs. 2 and 4 by J. H. Emerton.

Fig. 1. *Euphoberia hystricosa* †.
Fig. 2. *Acantherpestes inequalis* †.
Fig. 3. *Euphoberia hystricosa* †; reverse of fig. 1.
Fig. 4. *Acantherpestes inequalis* †.

PLATE 26.

Figs. 1, 3 and 7 are by Mrs. Katherine Peirson Ramsay; the others by J. H. Emerton.

Fig. 1. *Euphoberia spinulosa* †.
Fig. 2. *Euphoberia armigera;* a portion of the integument of one of the neighboring segments of fig. 8, further enlarged.

Fig. 3. *Euphoberia cuspidata* ½; the anterior extremity only.
Fig. 4. *Euphoberia armigera;* one of the peculiar structures of the opposite segment of fig. 8, further enlarged.
Fig. 5. *Euphoberia granosa;* a portion of the integument of one of the neighboring segments of fig. 6, further enlarged.
Fig. 6. *Euphoberia granosa* ½.
Fig. 7. *Euphoberia cuspidata* ½.
Fig. 8. *Euphoberia armigera* ½; several of the legs are still further enlarged and placed opposite their position on the body.

PLATE 27.

Figs. 1, 2, 4 and 5 are by J. H. Emerton; figs. 3 and 7 by Mrs. Katherine Peirson Ramsay; fig. 6 by J. Henry Blake.

Fig. 1. *Euphoberia spinulosa* ½.
Fig. 2. *Euphoberia simplex* ½; some of the legs still further enlarged are placed opposite their position relative to the body.
Fig. 3. *Euphoberia armigera* ½.
Fig. 4. *Euphoberia spinulosa* ½.
Fig. 5. *The same* ½; the head; from the reverse of fig. 4.
Fig. 6. *Euphoberia simplex* ½; the head and antenna of fig. 7.
Fig. 7. *The same* ½; the entire animal.

PLATE 28.

Figs. 1, 2, 3, and 5 are by Mrs. Katherine Peirson Ramsay; the others by J. H. Emerton.

Fig. 1. *Euphoberia tracta* ½.
Fig. 2. *Euphoberia granosa* ½.
Fig. 3. *Euphoberia anguilla* ½.
Fig. 4. *Euphoberia tracta* ½.
Fig. 5. *The same* ½.
Fig. 6. *The same* ½.
Fig. 7. *Euphoberia spinulosa;* the antenna of fig. 8, still further enlarged.
Fig. 8. *The same* ½.

PLATE 29.

Figs. 1–5, 7 and 9–11 are by Mrs. Katherine Peirson Ramsay; figs. 6 and 8 by J. Henry Blake.

Fig. 1. *Archiulus* sp ½.
Fig. 2. *Archiulus glomeratus* ½.
Fig. 3. *The same* ½.
Fig. 4. *Xylobius frustulentus* ½.
Fig. 5. *The same* ½.
Fig. 6. *The same* ½; a couple of segments from near the middle of the body of fig. 5.
Fig. 7. *Xylobius mazonus* ½.
Fig. 8. *The same* ½; three segments from the middle of the front half of the body of fig. 7.
Fig. 9. *The same* ½; a few of the terminal segments of fig. 7.
Fig. 10. *The same* ½.
Fig. 11. *The same* ½; reverse of fig. 10.

PLATE 30.

All the drawings are by J. H. Emerton.

Fig. 1. *Ilyodes divisa* ½.
Fig. 2. *Ilyodes elongata* ½.
Fig. 3. *Latzelia primordialis* ½.
Fig. 4. *Palenarthrus impressus* ½.
Fig. 5. *Eileticus anthracinus* ½.
Fig. 6. *Eileticus aequalis* ½.
Fig. 7. *The same* ½; side view of fig. 6.
Fig. 8. *The same* ½; reverse of fig. 6.
Fig. 9. *The same* ½.

SUMMARY LIST OF THE KNOWN PALEOZOIC MYRIAPODA OF NORTH AMERICA.

PROTOSYNGNATHA.

1. Palaeocampa anthrax Meek and Worthen. Mazon Creek, Ill.

CHILOPODA.

Gerascutigeridae.

2. Lazelia primordialis Scudd. Mazon Creek, Ill.

Eoscolopendridae.

3. Eileticus anthracinus Scudd. Mazon Creek, Ill.
4. Eileticus aequalis Scudd. Mazon Creek, Ill.
5. Palenarthrus impressus Scudd. Mazon Creek, Ill.
6. Ilyodes divisa Scudd. Mazon Creek, Ill.
7. Ilyodes elongata Scudd. Mazon Creek, Ill.

ARCHIPOLYPODA.

Euphoberidae.

8. Acantherpestes major Meek and Worthen. Mazon Creek, Ill.
9. Acantherpestes inequalis Scudd. Mazon Creek, Ill.
10. Euphoberia hystricosa Scudd. Mazon Creek, Ill.
11. Euphoberia horrida Scudd. Mazon Creek, Ill.
12. Euphoberia armigera Meek and Worthen. Mazon Creek, Ill.
13. Euphoberia granosa Scudd. Mazon Creek, Ill.
14. Euphoberia carri Scudd. Mazon Creek, Ill.
15. Euphoberia cuspidata Scudd. Mazon Creek, Ill.
16. Euphoberia flabellata Scudd. Mazon Creek, Ill.
17. Euphoberia spinulosa Scudd. Mazon Creek and Braidwood, Ill.
18. Euphoberia simplex Scudd. Mazon Creek, Ill.
19. Euphoberia tracta Scudd. Mazon Creek, Ill.
20. Euphoberia anguilla Scudd. Mazon Creek, Ill.
21. Amynilyspes wortheni Scudd. Mazon Creek, Ill.

Archiulidae.

22. Archiulus xylobioides Scudd. Joggins, Nova Scotia.
23. Archiulus glomeratus Scudd. Mazon Creek, Ill.
24. Archiulus sp. Malden Mine, W. Va.
25. Xylobius sigillariae Daws. Joggins, Nova Scotia.
26. Xylobius similis Scudd. Joggins, Nova Scotia.
27. Xylobius fractus Scudd. Joggins, Nova Scotia.
28. Xylobius dawsoni Scudd. Joggins, Nova Scotia.
29. Xylobius frustulentus Scudd. Mazon Creek, Ill.
30. Xylobius mazonus Scudd. Mazon Creek, Ill.

Illustrations of the Carboniferous Arachnida of North America, of the orders Anthracomarti and Pedipalpi.

THE present paper contains a discussion of all the carboniferous Arachnida of America, excepting Arthrolycosa, of which Mr. C. E. Beecher has lately given a fuller and more correct account than we have had before, and the scorpions, which will be treated on a future occasion. The descriptions of the previously known species are more detailed than at first, other new forms are added, and illustrations are given of all, except of *Architarbus rotundatum*, previously figured; with that exception it is the first attempt to figure the American forms in these groups. It should be added, however, that since these illustrations were prepared, further material has come to my hand, mostly from the rich collections of Mr. Lacoe and of Mr. Gurley, which may still further extend the list, but I have been obliged to leave them for another occasion.

Order ANTHRACOMARTI Karsch.

Body somewhat depressed, the cephalothorax and abdomen distinctly separable. Cephalothorax usually made up in large part of more or less wedge-shaped pedigerous segments, the arrangement of which corresponds to that of the coxae. Abdomen forming a single mass and composed of from four to nine distinct joints. Palpi not much longer than the legs and simply terminated.

This group, the only extinct order of Arachnida, was established by Karsch for some interesting carboniferous forms of somewhat obscure relations allied to the Phrynidae and Phalangidae, but very distinct from either of them. Its position seems to be between the Chelonethi and the Pedipalpi, to the latter of which it bears perhaps the closest relations. The Anthracomarti were the most varied in structure and, with the possible exception of the scorpions, the most abundant in species of the carboniferous Arachnida, and being unknown after that period they may be considered the most characteristic of paleozoic Arachnida. The forms here considered belong to two distinct families.

Family Poliocheridae Scudder.

Cephalothorax quadrate, not much smaller than the abdomen. Coxae radiating apparently from a median line. Abdomen rounded, of equal breadth with the cephalothorax, with very indistinct or no longitudinal sculpturing, composed of only four segments, of which the basal is very short and the others of equal length. No abdominal appendages.

A single genus and species are known, confined to North America.

Poliochera Scudder (πολιός, χείρ)

Poliochera Scudd., Proc. Amer. Acad. Arts Sc. xx, 16 (1884).

Cephalothorax quadrate, a little longer than broad, the front square, the sides nearly and the posterior border quite straight, the surface flat. Abdomen rounded subquadrate, a little longer than broad, its base completely sessile, as broad as the cephalothorax, the sides and extremity convex and with a continuous curve, the surface flat and on the same plane as the cephalothorax, the first segment short, the others large and equal, the transverse sutures straight. Legs stout, depressed, moderately long.

This very anomalous arachnid, the position of which seems to lie near the Architarboidae, must be referred to a distinct family as given above. It would seem not improbable that Kušta's genus Scudderia (name preoccupied in Orthoptera, — Stål, 1873) is nearly allied to this.

Poliochera punctulata.

Pl. 31, figs. 2, 6.

Poliochera punctulata Scudd., Proc. Amer. Acad. Arts Sc. xx, 16 (1884).

The front border of the cephalothorax is a little elevated, and behind it, extending nearly to the middle, a very broad, very shallow, transverse depression; there is also an equally slight but small central depression, but all of these scarcely affect the extreme flatness of the whole field which is shared also by the abdomen; both cephalothorax and abdomen are regularly and deeply punctate, as shown in fig. 6, excepting on the brief first abdominal segment which is only punctate along its hinder edge, and excepting also, as in the figure, in the division lines of the segments: the punctuation is perhaps a very little heavier on the cephalothorax than on the abdomen. The abdomen is also marked by slight straight lateral ridges, dividing the segments into three nearly equal parts which are only noticeable on the front half of the segments, but can be traced throughout; a moderately narrow and slightly elevated rounded bounding ridge seems to follow the entire rim of the abdomen. The legs are stout or at least all but the front pair, and all are long though none are preserved for their entire length; the basal joints of all of them are short, stout and quadrate, those of the front pair about half as stout as the others, and those of the third pair the stoutest of all; the joint beyond is long and only a little more than half as broad as the basal joint, those of the different legs of about equal length with each other and nearly as long as the width of the cephalothorax; the third

joints are all broken in the specimen, but on some of the legs at least were apparently about as long as the second joints; all the joints are flattened and punctate like the body, but not so deeply. The front pair of legs is about two-thirds as stout as the others and a little shorter.

Length of body, 15 mm.; cephalothorax, 6 mm.; first abdominal segment, 0.8 mm.; second, 2.3 mm.; width of cephalothorax posteriorly, 5.5 mm.; middle of abdomen, 6.5 mm.; length of second joint of first pair of legs, 4.5 mm.; its width, 0.6 mm.; length of first joint of second pair of legs, 2 mm., its width, 1.9 mm.; length of second joint of same, 5.5 mm., its width, 0.85 mm.; length of first joint of third pair of legs, 2.5 mm., its width, 2.25 mm.; length of second joint of same, 0.75 mm., its width, 1.25 mm.; greatest length of any leg (as far as preserved), 10.5 mm.

Mazon Creek, Ill. Mr. R. D. Lacoe, No. 1745.

Family Architarboidae Scudder.

Cephalothorax variable in form but at least half as large as the abdomen. Coxae radiating from a central pit, a median line, or from a broad triangular space, its base on the abdominal margin. Abdomen orbicular or oval, broad at base with a more or less distinct lateral ridge on each side, converging toward the anus; segments from seven to nine in number, visible below, though the basal ones often extremely shortened in the middle; no abdominal appendages.

This appears to be the best developed among the families of paleozoic Anthracomarti, especially in America where four genera occur, most of them, so far as known, peculiar to the New World.

Geraphrynus Scudder (γέρας, Phrynus, nom. gen.).

Geraphrynus Scudd., Proc. Amer. Acad. Arts Sc. xx, 16 (1884).

Allied closely to Architarbus; the body is compact with no constriction at the sides between the cephalothorax and abdomen, agreeing in its general structure with Architarbus, but differing from it considerably in detail. The contour of the body is ovate, but instead of being rounded in front as in Architarbus, it is pointed and angulate, while behind it is also pointed, though roundly. The cephalothorax occupies a little less than half of the body, and the pedigerous coxal segments which, as in Architarbus, are truncated wedge-shaped, enlarging distally, meet in a common median longitudinal ridge, the sides of which are rather strongly tectiform; this ridge runs from the extreme front to the posterior edge of the hindmost pedigerous segment, or through about two-thirds the length of the cephalothorax; behind it is the posterior shield of the cephalothorax, the anterior triangular fragment of which slopes upward to the ridge, while the hinder portions with their transverse scorings and ridgings lie on a plane below. Both anterior and posterior parts of this shield extend laterally nearly to the borders of the body, and are thus much broader and comparatively shorter than in our species of Architarbus.

The postthoracic plate is small and resembles that of Architarbus but is more triangular. The abdomen resembles that of *Architarbus rotundatum*, since this postthoracic plate, as

there, crowds down the middle of the six following segments, all of which reach the margin and are wider there than in the middle;[1] while the last three joints are, again as there, extremely broad and uniform; similar lateral furrows are also found in each.

This genus is American and a single species is known.

Geraphrynus carbonarius.

Pl. 32, figs. 1, 9, 10, 12.

Geraphrynus carbonarius Scudd., Proc. Amer. Acad. Arts Sc. xx, 16-17 (1884).

The median ridge of the cephalothorax (fig. 10) is flat upon the summit, with its lateral edges a little raised, so as to cause the rest to form a flat groove; the pedigerous coxal segments are very faintly punctulate, so as to be scarcely perceptible; the first pair taper more rapidly toward the interior than the others from the shape of this part of the body and terminate in a point, while the others present to the median ridge an edge; the others taper about equally, their interior margins being a little more than half as long as their exterior. The posterior shield has its front edges divaricating at considerably more than a right angle; at the base of the anterior sloping triangle is a transverse rounded ridge of considerable width, its posterior margin limited by a very broad and shallow double crescentic line; following this, opposite the anterior margins of the first abdominal segment is a similarly waved grooved ridge, the grooves of either side fading out before reaching the middle line; the sinuous posterior margin of the cephalothorax follows hard upon this. This posterior shield of the cephalothorax is faintly punctulate but more distinctly than the pedigerous segments (coxae).

The postthoracic shield is similarly punctulate, while the abdomen is profusely and rather distinctly punctate (fig. 9); the postthoracic shield is triangular, more than half as long as broad, extending laterally over about one-half of the body. The first six abdominal segments are uniform in size at the margin of the body where they occupy nearly one-half of the abdomen, but mesially are crowded down less and less strongly in passing backward, the last showing it more in being narrowed centrally than in any other way. The last three segments are equal in length though constantly decreasing in width, and the extremity of the body is marked by a circular impression. The lateral furrows of the abdomen extend from the third segment backward, being sharp on the narrower, deeply impressed but carrying the surface with it on the broader, segments, so as to leave the outer narrower portion arched. There is besides a faint ridge down the middle of either lateral half of the abdomen across all the segments, but fading out toward the hinder extremity.

Besides the body, however, there are several fragments of legs and palpi, the surface of all of which is heavily punctate. The palpi are the most perfect, nearly or quite the whole of one and half of the other being present; they are attached at the extreme front of the head and extend backward and outward on either side; they consist of seven joints, the first two small, quadrate, subequal, together reaching to the division line between the first and second pair of pedigerous segments, each a little longer than broad. The

[1] Nothing of this sort occurs in the English *Architarbus subvcale* Woodw., and it would appear probable that a different surface of the body was exposed; and as it seems tolerably clear that the dorsal surface of Geraphrynus is exposed, Woodward's specimen probably shows a ventral aspect.

next three segments are larger and longer, subequal, but each a little longer than the preceding, submoniliform, being largest apically, the angles rather square; the sixth joint is as long as the fifth but slenderer and equal, while the seventh is a mere rapidly tapering bluntly pointed cap to the sixth. The surface of all but the last three joints is flat or equally rounded, while these terminal joints have a common median ridge of considerable strength. As preserved, there is next the anterior margin a very deep rounded groove occupying nearly half the width of the joint; the opposite margin has also a pronounced but narrow groove and between them is a high rounded ridge, narrower than the first mentioned groove, terminating in the middle of the last joint where the lateral grooves join; they are slender. From the single fragment of one of the anterior pairs of legs that remains, apparently of the fifth joint, these were scarcely stouter; but the hinder pairs are twice as stout, and very heavily punctate; of the third pair the first four joints are preserved in whole or in part upon either side. The first joint is too obscure for description; it can only be said to have been small, and probably of the same size and perhaps of the same form as the second which is quadrate (it is only seen perfectly upon one side), about twice as long as broad; the third joint is of similar form but longer and perhaps slightly broader at its distal than its basal extremity; it is half as long again as the preceding joint, and is followed by a fourth joint exactly like itself; all the joints of this leg, with the possible exception of the basal, are heavily ridged as in the front legs but not so conspicuously. Of the fourth pair of legs only what are perhaps the third and fourth joints remain (and not completely); if they are these joints they agree altogether with those of the third pair of legs. The distinction in size between the base and apex of the joints of all the legs has been exaggerated by the artist.

Length of the body, 19 mm.; breadth of same, 9.5 mm.; length of median furrow, 6 mm.; last three abdominal segments, 6 mm.; palpi, 11 mm.; breadth of same, 5 mm.; length of third joints of third pair of legs, 2.5 mm.; breadth of same, 1 mm.

This description was originally drawn up from a single specimen from Mazon Creek, submitted to me by Mr. R. D. Lacoe under the number 1701ab. Since it was written, the same gentleman has sent me four more specimens from the same locality all of which are believed to belong here, although they range in size from 16.5 mm. to 21 mm. in length and from 8 mm. to 11 mm. in breadth. In one of them, No. 1701cd (fig. 1), the legs are unusually well preserved, one in particular, apparently the third pair, being nearly complete, showing nearly the whole of five joints, the terminal being simply pointed, and their size, counting from the tip, being as follows: first or terminal joint, length, 1.85 mm., breadth at base, 1 mm.; second, length, 2.2 mm., breadth at base, 1.5 mm.; third, length, 2.2 mm., breadth at base, 2 mm.; fourth, length, 2.1 mm., breadth at base, 2.1 mm.; fifth, length, 2 mm. The fourth pair of legs is slightly longer.

Geratarbus gen. nov. (γῆρας, τάρβος)

Cephalothorax suborbicular, the front rounded or very broadly angulate, about half as large as the abdomen, or a little more than that, but either distinctly narrower than the abdomen or separated from it by a marked lateral constriction. Coxae radiating from a short median line, which apparently lies at the bottom of a shallow central pit. Legs

stout and tolerably long. Abdomen oval, considerably constricted at the base, composed of nine segments, of which five of the basal ones are very narrow, at least on the under surface, but transverse and not angulate, the remainder longer and subequal or lengthening posteriorly.

This genus is so far known only from America by two very distinct species, both described below. It is possibly nearly related to Eotarbus Kušta from the Bohemian coal.

Geratarbus lacoei sp. nov.

Pl. 32, fig. 11.

The cephalothorax is nearly orbicular and the wedge-shaped pedigerous segments subequal; the posterior border shows a weak, broad, and rounded emargination. Only the very base of the first pair of legs can be seen; of the others on one side or the other three or four joints each; in the two middle pairs the first three joints are subequal, about half as long again as broad, flattened and a little arcuate, the anterior edge produced at tip and base, so as to form by the union of the adjacent joints a decided dentiform spine directed forward and outward, and more distinct on the second than on the third pair of legs, both of which curve forward; the last pair of legs is directed backward and is differently constructed, having no such compound tooth, though both outer and inner apices are slightly produced and rounded; the first joint is scarcely longer than broad, the second and third subequal and nearly twice as long as broad, all of similar breadth to those of the other legs.

The abdomen broadens rapidly from its base over the two basal segments until it is nearly a third broader than the thorax, then tapers, at first gently, afterwards rapidly, with a well rounded extremity, the whole only a little longer than the greatest breadth; all the joints are transverse, the first five very short, the sixth twice as long, the eighth three times as long, the seventh midway in length between these, and the last nearly equal in length to the preceding two. The lateral sulcus is distinct but not deep, separating a very narrow side piece from the main body of the abdomen.

The whole body is rather finely and uniformly punctate, the legs much more coarsely and distinctly.

Length of body, 11 mm.; cephalothorax, 4.8 mm.; abdomen, 6.2 mm.; breadth of thorax 4 mm.; abdomen, 6 mm.; length of second joint of second pair of legs, 1.3 mm.; of third pair, 1.5 mm.; of fourth pair, 1.8 mm.; breadth of last, 1.2 mm.

Mazon Creek, Ill. Mr. R. D. Lacoe, No. 1765ab.

Geratarbus scabrum sp. nov.

Pl. 31, fig. 5.

Cephalothorax apparently orbicular but for its truncate hinder extremity, but in the specimen turned a little so that the median line is thrown (as seen in the figure) to the left. The upper surface appears to be exposed so that the form of the subordinate parts can scarcely be seen. Fragments of the legs are preserved, showing parts of every pair but the first; all are flattened; the basal joints of the second and third pairs are more

than half as long again as broad and the three succeeding joints of the same are about two and a half times as long as broad, each more than half as long as the cephalothorax; the second joint a little the broadest, the others tapering slightly; the joints of the fourth pair are not very different.

The abdomen is shaped very much as in the last species but more smoothly rounded, much more elongated, being nearly twice as long as, and at its greatest only slightly broader than, the cephalothorax; the lateral sulcus, only distinguishable in places, is similarly close to the margin.

The whole body is coarsely, deeply and uniformly punctate, and the surface between the punctures apparently minutely and faintly punctulate, giving a scabrous appearance to the whole; the same is true of the legs though the puncta would appear to be a little shallower.

Length of body, 15 mm.; cephalothorax, 5.25 mm.; abdomen, 9.75 mm.; breadth of cephalothorax, 5.25 mm.; abdomen, 6.25 mm.; length of second joint of third pair of legs, 3 mm.

Mazon Creek, Ill. Mr. R. D. Lacoe, No. 1766ab.

Architarbus Scudder.

Architarbus Scudd., Geol. Surv. Ill., III, 568 (1868).

Cephalothorax orbicular, broadly rounded in front, much smaller than the abdomen, but not separated from it by a marked lateral constriction. Coxae radiating from a central pit. Abdomen oval, composed of nine segments, of which those on the basal half are very much shorter than the others, and on the dorsal surface are forced still more closely together by the large postthoracic plate.

Species of this genus are found in the coal measures of Silesia, Great Britain, and Illinois. In addition to the one long known from the last locality, another is described below.

Architarbus rotundatum.

Architarbus rotundatus Scudd., Geol. Surv., Ill., III, 568, fig. 4 (1868).

I have nothing to add concerning this species. It comes from Mazon Creek, Ill.

Architarbus elongatum sp. nov.

Pl. 32, fig. 4.

This species is remarkable for the great elongation of the abdomen which hardly tapers apically; it is twice as long as the cephalothorax and of equal breadth on the basal half, the last segment nearly as long as broad. On one face of the opened stone there appear to be only five abdominal segments, but on the opposite face, while the three apical segments remain the same, the basal portion is broken by very pronounced ridges and furrows into five short segments, together not half the length of the remainder of the abdomen. Only the merest fragments of the base of the legs are preserved. The

cephalothorax shows a shallow, profuse, moderately coarse punctuation; the abdomen a transverse, fine, but irregular corrugation in which the furrows seem occasionally to be deepened by punctures.

Length, 14.75 mm. (cephalothorax, 5 mm.; abdomen, 9.75 mm.); breadth, 5.25 mm.

Braidwood, Ill., from the same horizon as the Mazon Creek beds at Morris. Mr. R. D. Lacoe, No. 1702ab.

KUSTARACHNE (Kušta, nom. propr., ἀράχνη) gen. nov.

Proposed for a genus of carboniferous arachnids presumed to belong to the Anthracomarti and the family Architarboidae. The cephalothorax is orbicular, more or less embracing at its base the regularly ovate abdomen, but not so as to prevent a decided constriction between the two laterally. In the single specimen yet known, the elements are too uncertain to distinguish it in this part from the other genera. The legs which seem to have a stout basis are long and exceedingly slender. The palpi have the same slenderness but only the base is preserved. The abdomen proper is considerably larger than the cephalothorax, divided into seven segments, of which the first four are equal and longer than the last three, which are followed by a protuberant pygidium composed of two subsegments. It is possible that this was followed by a jointed seta; if so it could hardly fall in this place, but among the Pedipalpi where it would differ strikingly from the known forms. The irregular divisions of the abdomen do not disturb the regular curve of the sides.

Named in honor of Professor Johann Kušta of Rakonitz who has so greatly enlarged our knowledge of carboniferous Arachnida by his study of the coal-fauna of Bohemia.

Kustarachne tenuipes sp. nov.

Pl. 32, fig. 7.

The exact limits of the cephalothorax in the only specimen are rather obscure but so far as can be seen this region is orbicular with a slightly greater breadth posteriorly. The radiation of the coxae from the central pit is a little obscure, but unquestionable, and the pit opens posteriorly with flaring sides. The legs are excessively slender, long, straight, and almost thread-like, and the palpi have at base the same form, two short and slender joints of one being visible. The abdomen is very regularly oval, the broader basal extremity being sessile but having its basal suture well defined and the lateral excision at their boundaries distinct; the last three segments of the abdomen proper, which are equal, are about half as long as the four equal, basal segments; the terminal subsegments interfere with the regularity of the form of the abdomen, extending beyond the oval; the first is of the same length as the terminal segment, but only half its breadth and semilunar in form; at either side of its base a possible globular appendage appears to be present; the last segment is as long as the penultimate but much slenderer, being fully half as long again as broad; and there are some indications on the stone (which may be fortuitous) that it was followed by a slender seta; the surface of the abdomen is faintly and shallowly punctate. A straight belt of lighter color than the sides and as wide as the

terminal subsegment runs down the middle of the abdomen, but there is no sign of any lateral suleation as in neighboring genera. I have left in the figure the knob-like appendages mentioned above at the outer base of the apical subsegments of the abdomen, drawn by the artist, but I believe them to be purely accidental and perhaps wholly foreign to the creature as they are really distinctly present only on one side as a mere depression.

Length of body, 11.5 mm.; width of cephalothorax, 4.5 mm.; length of abdomen, not including terminal segments, 7 mm.; its width, 4.75 mm.; width of terminal subsegment, 1.25 mm.; length of legs (imperfect) beyond body, 13 mm.; their width, 0.3–0.5 mm.

Mazon Creek, Ill. Mr. R. D. Lacoe, No. 1756 ab.

Anthracomartus Karsch.

Anthracomartus Karsch, Zeitschr. deutsch. geol. Gesellsch., 1882, 560 (1882).

Cephalothorax quadrate, the front square, or scarcely convex, about half the size of the abdomen; the coxae laterally affixed, radiating from a broad triangular sternal plate, the base of which forms the posterior margin. Sides of the body showing a distinct though slight constriction between the cephalothorax and the abdomen by the more convex sides of the latter. Abdomen orbicular, a little longer than broad, composed of seven segments of similar length.

This is apparently the most abundant type of Arachnida in the carboniferous formation. Kuśta has found four or five species in Bohemia alone, one is found in Silesia, another in Belgium, and at least two in our own coal. These last are described below.

Anthracomartus trilobitus.

Pl. 31, figs. 7–10.

Anthracomartus trilobitus Scudd., Proc. Amer. Acad. Arts Sc., xx, 17 (1884); Comptes rend. soc. ent. Belg. (3) No. 62, p. 85, fig. (1885).

Although more than half a dozen specimens of this species have been obtained, the abdomen is the only part that has been secured in a complete condition, the cephalothorax being incomplete if present, and the appendages in no case present. It offers, however, striking differences from the other species known. The cephalothorax was hexagonal in outline, the front and hind margins forming the longest and subequal sides, and the lateral margins being roundly angulated behind the middle, the hinder lateral margins formed the shortest sides of the hexagon; the front is nearly straight, slightly convex, and a little longer than the straight or even slightly concave hind margin; the surface is nearly flat but slightly domed, with the transversely ridged hinder margin separated from the main mass by a straight transverse furrow. The abdomen is very broad and well rounded, excepting in front where the extremely broad base is almost straight, gently convex, and on each side extends far beyond the cephalothorax, being even here, where the abdomen is narrowest, wider than the widest part of the cephalothorax; and as the hinder portion of the cephalothorax rapidly narrows backward, an unusually deep excision separates it from the abdomen. The outer angles of the base of

the abdomen are distinct and not rounded, and the first course of the lateral slope as the abdomen enlarges is in exact continuation of the direction of the anterior half of the sides of the cephalothorax; the abdomen widens to beyond its middle, so as to be half as broad again as the cephalothorax, and then narrows, the outline of its apical half being an almost exact semicircle with the central point of the abdomen (near the middle of the fifth segment) for its centre. A scalariform incised line runs on either side obliquely inward from opposite the outer limits of the cephalothorax to either side of and in close proximity to the large circular or more often transversely oval anus, dividing the body into three subequal longitudinal thirds and giving it a trilobitic aspect, which is more pronounced from the fact that the central region is nearly flat or only slightly domed, while the sides fall off as far as the again flat, lateral flanges; these are separated about as distinctly from the rest of the body by an incised line subparallel to the margin and dividing the lateral lobes as a whole into nearly equal halves, extending also across the middle of the seventh segment and dividing it just beyond the anus into an anterior and posterior half.

The entire surface of both cephalothorax and abdomen is delicately, uniformly, and rather sparsely granulate. In the original description it was described as punctate, but this is apparently a mistake, the surface being punctate only in casts, though it is difficult in the flattened condition of all the specimens to speak confidently.

Length of cephalothorax, 5.25 mm.; its greatest width, 6.75–7.5 mm.; width at posterior extremity, 4.5–5.5 mm.; length of abdomen, 8–12.5; width at base, 5.75–8.25 mm.; at widest point, 8–12.5 mm.

The specimens were found on a dark gray carbonaceous shale associated with ferns, in the subconglomerate coal measures six miles northeast of Fayetteville, Ark., by Prof. F. L. Harvey of Fayetteville. Some of the specimens are in Mr. R. D. Lacoe's collection under the number 1753.

Anthracomartus pustulatus.

Pl. 32, figs. 5, 8.

Anthracomartus pustulatus Scudd., Proc. Amer. Acad. Arts Sc., xx, 18 (1884).

The stone on which the single known specimen occurs is broken just at the front edge of the cephalothorax, as is shown by the course of the front pairs of legs and of the palpi in the face of the broken wall (fig. 5). If this break has not interfered, as looks possible, with a projecting front, the cephalothorax was squarely truncated in front and was of a quadrate form, narrower, however, in front than behind and with tolerably straight sides, the hind margin straight or a little concave. The surface of the cephalothorax is however the most remarkable thing about it, the sides being strongly elevated, and the middle third deeply sunken in a longitudinal furrow rapidly widening posteriorly, from the bottom of which a sharp median ridge arises with abrupt sides, gradually increasing in elevation and thickness from the middle of the front half where it arises, to the middle of the hinder half where it abruptly terminates, but nowhere rising to half the height of the sides. The abdomen on the contrary is strongly arched, the central field somewhat flattened and separated from the lateral by distinct carinae. The outline of the abdomen,

though nowhere seen on the stone, appears to be regularly obovate, broadest at or before the middle and much broader than the cephalothorax, with which it appears to be united throughout the base, the sides of the body showing little excision at their junction. The abdominal segments are equal in length. The entire surface of both cephalothorax and abdomen is closely covered with very irregularly polygonal, or rounded subovate, sunken cells of varying size, but generally tolerably large, the largest forming pyriform cells lining internally the abdominal carinae, one to each segment, the broadest end anterior. The legs are moderately stout, very long, thickened at the joints, the fourth pair apparently the longest, the first pair comparatively small; the palpi, as far as they can be seen, apparently similar to the front legs but still smaller.

Length of body, 15 mm.; cephalothorax, 6 mm.; abdomen, 9 mm.; width of cephalothorax in front, 4 mm., behind, 7 mm.; abdomen, 8 mm.; length of first two joints of first pair of legs, 4.5 mm.; of third pair, 5 mm.; of fourth pair, 5 mm.; first four joints of third pair of legs, 12 mm.; of fourth pair, 13.5 mm.; length of second joint of first pair of legs, 3 mm.; of same (?) joint of palpi, 1.75 mm.

Mazon Creek, Ill. Collection of Mr. R. D. Lacoe, No. 1752.

Order PEDIPALPI Latreille.

Family GERALINURIDAE Scudder.

Cephalothorax divided into two masses: the hinder much the smaller, short and transverse, and carrying only the hindmost legs; the front portion large, tapering anteriorly, and furnished with long and slender cheliceres. Abdomen subfusiform. While most nearly related to the Thelyphonidae, this family, by the division of the cephalothorax, shows some affinity to the Nyctalopidae. Two genera have been found belonging here.

GRAEOPHONUS gen. nov. (γραῖος, φόνος).

Cephalothorax remarkably short and stout, rounded quadrate (especially rounded in front, nearly quadratiform behind, the sides nearly straight, the hinder margin gently convex), divided into radiating pedigerous segments. Palpi very stout, chelate at tip. First pair of legs like the others in all general respects, very stout, flattened and tapering, of no great length. Abdomen ovate, largest in the middle, rather narrowly attached at base, composed of twelve similar segments, excepting that the last three rapidly narrow and are considerably shorter than the others, but the posterior curve of the abdomen is not interrupted to form a post-abdomen as in other Pedipalpi. Whether an articulated seta follows the last joint cannot be told from the specimen preserved; a pair of distant, distinct, and divergent furrows are seen on the first and second abdominal segments of a cast of one specimen, reaching halfway across the second segment, and occupying the place which the "combs" of modern scorpions occupy.

This genus pretty plainly falls into the Pedipalpi on account of the stout chelate palpi and the number of abdominal joints; but the absence of a post-abdomen, perhaps also of a seta, the undifferentiated character of the first pair of legs and the radiated arrange-

ments of the pedigerous segments of the cephalothorax separate it widely from all known Pedipalpi ancient or modern. In the characteristics of the body proper it approaches decidedly the contemporaneous Anthracomarti.

Graeophonus carbonarius.

Pl. 32, figs. 2, 3, 6.

Libellula carbonaria Scudd., Can. nat., (2), VIII, 88–89, fig. 1 (1876).

Cephalothorax (fig. 3) quadratiform posteriorly, the hinder angles scarcely rounded, the hinder margin gently convex, and the sides straight; anteriorly the front is regularly and rather strongly convex, the whole cephalothorax being nearly half as broad again as long; on the posterior half is a sharp and deep median sulcation which increases in depth posteriorly and at the posterior limit ends in a circular pit which appears to involve also a part of the first abdominal segment. The whole surface is minutely and delicately punctate, as is also that of the legs and palpi. What are apparently the third joints of the legs are disproportionately long and tapering. The abdomen is regularly obovate, nearly twice as long as broad, the first to the fifth joints longer and equal, the sixth to the ninth slightly shorter and subequal, the tenth to the twelfth scarcely more than half as long as those directly preceding. The surface of the abdomen is punctate as the rest of the body.

Length of whole body, 15.5 mm.; cephalothorax, 5 mm.; abdomen, 10.5 mm.; breadth of cephalothorax, 7 mm.; abdomen, 7 mm.; length of palpi, 6 mm.; breadth of palpi, 1.6 mm.; longest fragment of legs (second pair), 12 mm.; apparent length of third joint of this pair of legs, 7.5 mm.; its breadth at base, 1.75 mm.; at tip, 1 mm.

Mazon Creek, Ill. Collection of Mr. R. D. Lacoe, No. 1762.

The above description was drawn up from the specimen above mentioned before it was recognized as the same species as that described by me many years ago from an abdomen alone, under the name of *Libellula carbonaria*, presuming it to be a larva. A direct comparison of the two, for the opportunity for which I am indebted to the kindness of Sir Wm. Dawson, leaves little doubt on this point. No marks of divergent furrows or ridges can be seen on the basal segments, however (figs. 2, 6), and it further differs from the above in that the posterior border of the eighth segment is broadly, roundly, and rather deeply excised. In addition one may see large, faint, shallow depressions on either side of each of the larger segments, at equal distances from either border and the lateral ridge, which look as if in the position of stigmata. Finally there is a mesial, apical, small, triangular depression on the last segment as if the cast of a basal fragment of a seta, and which formerly led me to think the segment bilobed.

The specimen is 14 mm. long and 8.25 mm. broad, though apparently it is crushed out of shape a little, and should be considered 7.2 mm. broad.

The specimen comes from Cape Breton and is now in the museum of McGill College, Montreal.

GERALINURA Scudder.

Geralinura Scudd., Proc. Amer. Acad. Arts Sc., XX, 19 (1884).

Cephalothorax ovate, the front rounded, narrower than the squarely truncate posterior

margin, the sides well rounded, the whole not more than half as large as the abdomen, which is cylindrical, perhaps depressed, and composed of nine principal joints, of which the first three are a little shorter than the others, followed by a post-abdomen of three much contracted joints, and this by the jointed thread peculiar to the family, and which is as long as the abdomen. A pair of eyes on the front of the cephalothorax. Palpi large, robust, composed of three similar joints, spinous within, and the apical coarsely chelate. First pair of legs thread-like, no stouter than the tail, and longer than it; second and third pairs of legs moderately slender, equal, the last pair similar but considerably longer, supported by a transverse independent joint between the cephalothorax and abdomen.

This genus, first described in June, 1884, was brought to the attention of the American Academy only nine days before another species of the same genus was described by Kušta to the Bohemian Academy; a fact the more striking since up to that time no Pedipalpi had ever been found fossil even in tertiary or secondary rocks, unless credit be given to Serres' mention of a species in the tertiary marnes of Aix. Kušta has since described several species from the Bohemian coal.

Geralinura carbonaria.

Pl. 31, figs. 1, 3, 4.

Geralinura carbonaria Scudd., Proc. Amer. Acad. Arts Sc., xx, 19–20 (1884).

Cephalothorax broadest in the middle, but tapering more rapidly in front than posteriorly, the front triangularly produced but the extreme tip rounded; apparently a pair of globular eyes are situated in front as in *G. bohemica*, but larger, notwithstanding that they are seated on a much narrower spot. The front pair of legs are of the same size as the tail; the second pair have the femur hardly half so stout as that of the hind pair, which is nearly as broad as one of the middle abdominal joints, that of the middle pair approaching the former rather than the latter. The abdomen is regularly obovate, twice as long as the thorax even excluding the post-abdomen, and half as broad again as that. The post-abdomen composed first of two joints, together half as long as broad and one-third as broad as the abdomen, next of a single quadrate joint, followed by the thread which is about one-fourth or one-fifth as broad as the tip of the post-abdomen, and about as long as the body, composed of numerous joints, as far as can be seen about twice as long as broad. In one of the two specimens found, the body is piceous from carbonaceous matter, but interrupted at the abdominal interstices and traversed irregularly by broken, longitudinal, slenderer interruptions of the color of the stone.

Length of body to base of tail (*a*), 16 mm.; (*b*), 13 mm.; of tail (*a*, broken), 4 mm., (*b*, probably perfect), 12 mm.; of cephalothorax (*a*), 4 mm.; postthoracic plate (*a*), 0.75 mm.; abdomen (*a*), 8.5 mm.; postabdomen (*a*), 2.5 mm.; breadth of cephalothorax (*a*), 2.6 mm.; postthoracic plate (*a*), 1.75 mm.; abdomen (*a*), 4.5 mm.; postabdomen (*a*), 1.4 mm.; thread (*a*), 0.25 mm.; breadth of first pair of legs (*a*), 0.25 mm.; second pair (*a*), 0.5 mm.; third pair (*a*), 0.75 mm.; fourth pair (*a*), 1 mm.; length of femora of third pair (*a*), 3.5 mm.; of fourth pair (*a*), 5 mm.

Mazon Creek, Ill. Mr. R. D. Lacoe, two specimens, Nos. 1754a–d.

The species differs considerably from *G. bohemica* Kušta sp., first in its much smaller size, then in its much more pointed and ovate cephalothorax. It would appear indeed

as if Kušta had more than one species before him, as his figures I and IV differ remarkably, fig. I having a cephalothorax scarcely half so long in proportion to its breadth as fig. IV, and its abdomen is strongly constricted at the base, while in fig. IV the latter only tapers gently in front. Our own species has the abdomen much broader and larger than the cephalothorax, and tapers in front considerably but not so rapidly as in Kušta's fig. IV. More recently Kušta has described other species, but they seem no nearer ours.

EXPLANATION OF PLATES.

PLATE 31.

Figs. 1 and 3 are by J. Henry Blake; figs. 2, 5–8, 10 by Mrs. Katherine Peirson Ramsay; figs. 4 and 9 by J. H. Emerton.

Fig. 1. *Geralinura carbonaria* $\frac{3}{4}$.
Fig. 2. *Poliochera punctulata* $\frac{3}{4}$.
Fig. 3. *Geralinura carbonaria* $\frac{3}{4}$.
Fig. 4. *The same* $\frac{3}{4}$.
Fig. 5. *Geratarbus scabrum* $\frac{1}{4}$.
Fig. 6. *Poliochera punctulata* $\frac{1}{1}\frac{0}{0}$; a fragment from the middle of the abdomen to show surface structure.
Fig. 7. *Anthracomartus trilobitus* $\frac{1}{4}$.
Fig. 8. *The same* $\frac{1}{4}$.
Fig. 9. *The same* $\frac{3}{4}$.
Fig. 10. *The same* $\frac{1}{4}$.

PLATE 32.

Figs. 1, 3, 4, 7, 12 are by J. H. Emerton; figs. 2 and 6 by S. H. Scudder; figs. 5, 8, 11, by Mrs. Katherine Peirson Ramsay; and figs. 9 and 10 by J. S. Kingsley.

Fig. 1. *Geraphrynus carbonarius* $\frac{3}{4}$.
Fig. 2. *Graeophonus carbonarius* $\frac{1}{4}$.
Fig. 3. *The same* $\frac{3}{4}$.
Fig. 4. *Architarbus elongatum* $\frac{3}{4}$.
Fig. 5. *Anthracomartus pustulatus* $\frac{3}{4}$; front view.
Fig. 6. *Graeophonus carbonarius* $\frac{3}{4}$.
Fig. 7. *Kustarachne tenuipes* $\frac{3}{4}$.
Fig. 8. *Anthracomartus pustulatus* $\frac{1}{4}$.
Fig. 9. *Geraphrynus carbonarius* $\frac{6}{1}$; a portion of the first broad abdominal segment, to show the surface structure.
Fig. 10. *The same* $\frac{3}{4}$.
Fig. 11. *Geratarbus lacoei* $\frac{1}{4}$.
Fig. 12. *Geraphrynus carbonarius* $\frac{3}{4}$.

The Insects of the Triassic Beds at Fairplay, Colorado.

EARLY in 1882, Mr. Arthur Lakes, professor in the Colorado School of Mines, discovered a bed of plants and insects near Fairplay, Colorado, in rocks much older than any that had before yielded insect remains west of the Great Plains; the two or three specimens he sent me were sufficient to prompt a more thorough exploration of the locality, which I was able to make the following summer, resulting in the discovery of a fauna and a flora of considerable interest.

The plants have been studied by Mr. Lesquereux,[1] who pronounces the species, some thirty in number, but in a very fragmentary condition, to belong to permian types, and declares the evidence to be decisive on this point.

The animal remains consist almost exclusively of insects, and are two-thirds as abundant in species as the plants, an exceptionally large ratio in beds where both occur. These insects form an assemblage wholly different from anything before known, and, in contradiction to what Mr. Lesquereux says of the plants, clearly belong to types of a more modern character than any the paleozoic series has yet disclosed. It is not often that one may speak so positively in the discussion of fossil insects, especially when not a single one of the species and only the smaller portion of the genera found have been previously known. But in this case all but two or three of the specimens obtained (some eighty in number) belong to a group which of all paleozoic insects has received the most attention, namely, the cockroaches. This great preponderance of cockroaches, and the fact that the known genera found in this collection have hitherto been discovered only in carboniferous and permian rocks, would lead us at first to refer the beds in which they occur to one of the paleozoic series; but the presence of the other forms, and even the characteristics of those which are referable to carboniferous and permian genera, unmistakably point to a later horizon.

As has been repeatedly pointed out by me, paleozoic cockroaches are distinguished

[1] On some specimens of permian fossil plants from Colorado. Bull. Mus. Comp. Zool., vii, 243.

from living types by the complete interdependence of two of the veins of the fore wing, and by the fact that the anal veins of the same wing impinge successively upon the inner margin and do not either fall upon the anal furrow or become clustered together at the outer point of the anal area; and I have accordingly grouped them under the name Palaeoblattariae to distinguish them from their descendants the Blattariae proper. Now as not only all the living cockroaches belong to the Blattariae proper, but the same is true of all mesozoic cockroaches later than the trias,[1] it becomes a matter of special interest to inquire into the position of these Fairplay cockroaches, which number eighteen species.

Eleven of the species and five of the seven genera belong to the Palaeoblattariae. These five genera are Etoblattina (2 sp.), Spiloblattina (4 sp.), Anthracoblattina (1 sp.), Petrablattina (2 sp.), and Poroblattina (2 sp.). Only five of the species belong to genera previously known, Spiloblattina and Poroblattina having been established upon and still being known only by the Fairplay fossils. But the difference is more marked than this; for at least one of the species referred to Etoblattina is an aberrant form with an excessively long internomedian vein; and both the species of Petrablattina agree in differing from those heretofore known to a very considerable degree. Of the new genera, Spiloblattina is very peculiar in the strongly divergent and then convergent curve of the externomedian and internomedian veins around a large stigma near the middle of the wing, unknown in any other cockroach, ancient or modern, so far as I know; but otherwise it is related to Etoblattina; while Poroblattina is more nearly related to Petrablattina, and especially to the two new species of that genus from this locality.

The average size of these Fairplay Palaeoblattariae is much less than that of the paleozoic Palaeoblattariae in general. The average length of the front wings of the paleozoic species is 26 mm.; that of these Fairplay Palaeoblattariae, 16 mm. This fact has its value, for the jurassic species are nearly all of very small size, and the wing-length of the remaining species from Fairplay (*i. e.*, those which do not belong to the Palaeoblattariae) is less than 8.5 mm., ranging from 6.5–11.5 mm. This agrees completely with the size of mesozoic species already known. The average of all the Fairplay cockroaches is less than 13.5 mm.

As to the seven cockroaches from Fairplay which belong to the Blattariae, the characteristics of their venation as well as their small size show them to be closely allied to jurassic forms, although the two genera to which they belong are peculiar so far as yet known to Fairplay. One of them is distinctly allied to Rithma, as defined by me in my memoir on mesozoic cockroaches (*loc. cit.*), while all the species have a decided mesozoic aspect and would at once be considered liassic or at least jurassic by any one at all familiar with the forms already known from these deposits. They have on the other hand an entirely different aspect from any and all paleozoic forms, and present no points of close comparison with any Palaeoblattariae excepting some of those mentioned above from the same Fairplay beds, notably with the genus mentioned under the name of Poroblattina, which one of the genera not a little resembles. The manner in which the change of the venation was brought about has been stated by me in my memoir on mesozoic cockroaches.

[1] See Mem. Bost. Soc. Nat. Hist., III, 439 *seq.*

The few insects other than cockroaches emphasize the mesozoic aspect of the rest of the fauna.

We have then at Fairplay an assemblage of forms altogether different from anything hitherto found in the paleozoic series on the one hand, or in the jurassic beds on the other. They show a commingling of strictly jurassic forms with a larger proportion of types which may be called upper carboniferous or permian with a distinct jurassic leaning. There is therefore a strong probability that the beds in which they occur belong to the intermediate formation, the triassic.

If this should be proved, Mr. Lake's discovery will have an added interest, from the fact that almost nothing is known either of the plants or of the insects of this formation. Of the plants, it is only necessary to point out that in the paucity of data, the upper paleozoic aspect of the few vegetable remains from Fairplay can have but a negative value beside the positive proof of the alliance of the insects to mesozoic forms. Of triassic insects our knowledge is exceedingly meagre; a single neuropterous larva from the Connecticut valley is all that the formation has hitherto yielded in this country. In Europe we know of only four species, each, I believe, from a single specimen; one of these is a cockroach, but it is entirely different from any of the Fairplay species, and indeed from any other known forms, so that we get no light from this quarter.

So far as I know this is the first attempt to determine the age of a deposit from its insect remains alone, and it is unfortunate for its acceptance by naturalists that the plants give it, to say the least, no support, but rather are deemed by one competent to judge, to be decidedly adverse to what is here claimed.

The paleontological contradiction shown in the plants and animals of the Fairplay beds is not unknown to American geology, as every one is aware, but I do not know that it has been pointed out in this country at this horizon or in this direction, the discordance appearing later in time, and the plants indicating a younger and not an earlier age than the animals. An exactly parallel case appears to be shown in eastern Russia, for in discussing the poorer strata of Kargalinsk, which he refers to the permian, Twelvetrees says, "as regards the flora [eleven species] the list has a paleozoic aspect, but a secondary one as respects the reptilians remains" [four species cited.][1]

All the specimens are in my own collection.

PALAEOBLATTARIAE Scudder.

ETOBLATTINA Scudder.

Etoblattina persistens sp. nov.

Pl. 33, fig. 7; pl. 34, figs. 10, 19.

The fore wing is a little less than two and a half times as long as broad with a moderately convex costal margin and apparently a full and well rounded apex. The mediastinal vein extends somewhat beyond the middle of the wing and is provided with

[1] Quart. Journ. Geol. Soc. Lond., XXXVIII, 495.

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numerous oblique simple branches. The scapular reaches nearly to the tip of the wing, running in a nearly straight course, most distant from the costal margin in the middle of the wing; it begins to branch just beyond the basal third of the wing, and sends to the costal margin half a dozen or less oblique branches, subparallel to the mediastinal branches, but apically growing more longitudinal, any of which may, and the greater number do, fork at less than halfway to the margin. The externomedian vein occupies the centre of the wing, and with its branches feeds narrowly the apical margin, for it only forks three times, usually simply, near the centre of the wing, beginning a trifle earlier than the scapular vein, and the long branches are wholly longitudinal and closely crowded. The internomedian starts as if to terminate with a gentle arcuation before the middle of the outer half of the wing, sending off half a dozen moderately distant, usually simple but sometimes deeply forked, slightly sinuous, parallel, oblique branches; but when it reaches the middle of the wing, it throws off from its other side a couple of deeply forked or compound, nearly straight, crowded, longitudinal branches, which extend the range of the internomedian area almost to the very tip of the wing. The anal furrow is moderately impressed, strongly arcuate or almost bent, and the anal veins simple, moderately frequent, also strongly arcuate, and parallel.

To this species I refer with little doubt (if it belongs to any of the species here described) a prothoracic shield, independently preserved in the same shales. It is pretty strongly domed, rounded subtriangular, more than a third as broad again as long, strongly rounded in front, centrally subtruncate behind; the surface is smooth and the margins entire, but the disk shows a little behind the middle a very faint subtriangular depression, one-fourth the size of the pronotum, the apex posterior.

Length of wing, 20 mm.; breadth, 8.4 mm.; length of pronotal shield, 7 mm.; breadth, 9.75 mm.

Four fragments of wings were found, with a single pronotum, Nos. 21 and 65, 22, 29 and 69, 66, 67 and 68. The species is clearly different from anything before described, but in the apical reach of the internomedian area and the means of securing it, it resembles the later carboniferous Etoblattinae.

Etoblattina sp.

Pl. 34, fig. 20.

A second and smaller species of Etoblattina is indicated by the poorly preserved fore wing and its reverse figured as above. Like the preceding, it is about two and a half times longer than broad, with well arched costal margin, and the general course of the veins shows that it is nearly allied to that species; the details of the neuration, however, are very obscure. The mediastinal vein reaches the end of the middle third of the wing. The scapular occupies about the same area as in the preceding species, and with very similar, crowded, pretty longitudinal veins. The externomedian is more obscure. The internomedian certainly differs in that the inferior branches are fewer, more longitudinal, and far longer, but there is apparently, though this is uncertain, a somewhat similar apical extension of this area, and apparently by a similar method. The anal furrow is ar-

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cuate, but more broadly than in *E. persistens*, and the anal veins similarly arcuate, longer, and perhaps less numerous.

Length of wing, 12 mm.; breadth, 5 mm.

A single specimen and its reverse, Nos. 28 and 70.

Spiloblattina Scudder.

Spiloblattina Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 35–36.

This genus is allied to Etoblattina, but differs from it and from all other genera of Blattinariae in the divergence of the scapular and externomedian veins beyond the middle of the wing, and then their rapid convergence beyond a more or less conspicuous elongated spot (whence the generic name) which fills the space so produced; a similar arrangement is seen even more conspicuously between the externomedian and internomedian veins, where the spot is much larger and round.

This genus is only known from the Fairplay triassic, where four species occur. *S. gardineri* may be considered the type.

TABLE OF THE SPECIES OF SPILOBLATTINA.

Scapular vein as far as its penultimate branch almost completely parallel to the costal margin, not receding from it opposite the middle of the adjoining discal stigma.
- Wings relatively slender, fully three times as long as broad.
  - Scapular faintly approaching the externomedian vein to enclose the stigma between them . **1. S. gardineri.**
  - Scapular in no way approaching the externomedian vein to enclose the stigma between them **2. S. triassica.**
- Wings relatively broad, not over two and a half times longer than broad . . . . . **3. S. guttata.**

Scapular vein distinctly receding from the costal margin opposite the middle of the adjoining discal stigma **4. S. marginata.**

1. Spiloblattina gardineri.

Pl. 33, figs. 4, 6, 8, 10.

Spiloblattina gardineri Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 36.

This was the most common species found at Fairplay, and a number of tolerably perfect fore wings well exhibit the characteristic discal stigma of the wings; some hind wings also occurred, and one somewhat crushed specimen with parts of all the wings and some of the body. The fore wing is long and slender, more than three times as long as broad, the costal margin very gently convex, the tip produced and attenuated but rounded. The mediastinal vein terminates some way beyond the middle, approaching the margin very gradually and emitting numerous parallel simple veins. The scapular vein runs parallel to the costal margin, slightly more removed from it in the apical than in the proximal half, and terminates a little before the tip of the wing; it first branches a little before the middle of the wing, and has many offshoots usually forked, sometimes, especially the first one, compound. The externomedian vein usually begins to branch beyond the middle of the wing opposite the distal end of the stigma between it and the scapular vein, and its longitudinal, more or less forked branches, which are sometimes superior, sometimes apical, fill the apex of the wing; to form the enlarged cell for the larger stigma, the curve of the main externomedian vein is graceful and gradual. The internomedian vein at first descends rapidly toward the margin as if to terminate near the middle of the outer half, but shortly before reaching it, it bends outward with a sinu-

ate curve embracing the discal stigma next it and terminates about as far out as the scapular vein; its branches are almost always simple, gently arcuate, and more distant than in other parts of the wing, except those that arise nearest the somewhat sudden and considerable turn in direction, where they are generally deeply forked. The anal furrow is not pronounced, almost bent rather than arcuate, and terminates hardly beyond the basal third of the wing.

The whole wing is of a dark color, excepting for the two stigmas which are light or diaphanous and for occasional light streaks in the broader spaces, particularly in the neighborhood of the stigmas and on the costal side; besides, the whole wing, as also the hind wing, is covered with a delicate scarcely perceptible mesh of fine lines.

The outer half or less of the hind wings is preserved in several instances, showing that this wing was of about the same length as the fore wing but of a different shape, having a straighter costa, a fuller hind margin, and a more pointed apex, which was far above the middle line of the wing. The mediastinal area (fig. 4) was very narrow, and subequal, terminating somewhat abruptly when it had extended over nearly five-sixths of the wing, and had numerous very oblique branches. The scapular does not branch before the distal third of the wing, and then reaches with a few longitudinal and mostly simple veins to the tip. The externomedian area is narrowly fan-shaped, the first divarication occurring near the middle of the wing and most of the forking of the longitudinal branches near the middle of the apical half. The internomedian vein reaches a little further out than the scapular, but the main vein is nearly straight, and the branches mostly simple, and only gently arcuate and parallel, so as to be very different from the fore wing.

The pronotal shield can be seen and then but obscurely only in a single instance. It appears to be rather small and transversely obovate.

Length of fore wing, 17.5 mm.; breadth, 5.5 mm.

Eleven more or less perfect specimens were found by our party, the first and best specimen (fig. 6) by my son. I have accordingly named the species for him.

2. Spiloblattina triassica.

Pl. 33, fig. 1.

Spiloblattina triassica Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 36.

Two incomplete fore wings are preserved showing that the species is nearly allied to the last; the veins are more delicate, however, and have other differences which will be pointed out. Although only the costal margin is in any degree preserved, and this is straighter than in *S. gardineri*, the form of the wing appears to be essentially the same and with the same proportions. The mediastinal vein and its branches are precisely as in *S. gardineri*. The scapular vein is also very similar, and its branches similarly arranged and forked, but they are a little more longitudinal and arise earlier, the first some way before the middle of the wing; the main vein is also exceptionally straight, showing, as it passes the stigma between it and the externomedian vein, no disposition to curve toward the latter. The externomedian vein is practically a repetition of the same vein in *S. gardineri*. The internomedian passes at rather a less distance from the preceding

vein than in *S. gardineri*, producing a small stigma, but its further structure cannot be told from either of the specimens, and the anal area is not preserved.

In this species the wing appears to be more slender than in the others, although the exact proportions cannot be given from the imperfection of the specimens; all the branches have a more longitudinal and less arcuate course, the externomedian and scapular veins scarcely part from each other to give place to the stigma, and the divergence of the former and the internomedian veins is also less conspicuous. The wing was probably about 15 mm. long, and 5 mm. broad.

Two specimens obtained, Nos. 23, 59 and 60.

3. Spiloblattina guttata.

Pl. 33, fig. 2; pl. 34, fig. 14.

Spiloblattina guttata Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 36–37.

Although no perfect fore wing has been discovered, it was evidently stouter than in the other species found and was perhaps not much more than twice as long as broad; the costal margin is nearly straight in the middle. The mediastinal area is wider than in the other species, terminating more abruptly, and is filled with less longitudinal branches pretty closely crowded; it terminates directly opposite the scapular-externomedian stigma, or a little earlier than in *S. gardineri*. The scapular vein runs in a nearly straight but slightly sinuous course at a considerable distance from the mediastinal; its branches, at first compound, afterwards deeply forked and then single, are five or six in number, scarcely more longitudinal than the mediastinal branches, and it would appear as if the last could not come very near the tip of the wing as it does in *S. gardineri;* the first vein is given off about opposite instead of far before the last branch of the mediastinal and after its second branch it begins gently to recede from the costal margin to share in the embrace of the adjoining stigma. The externomedian vein first forks about opposite the end of the mediastinal area, and sends four or more longitudinal mostly simple branches to the apical margin, the basal arcuation of the first branch serving for the embrace of the smaller, the sinuous course of the main vein for that of the larger, stigma. The internomedian vein has the same strongly sinuous course as in *S. gardineri*, and the branches are arcuate, distant, parallel, and so far as can be seen, all simple. Anal area unknown.

There is a single hind wing (fig. 14) which appears to belong here as it agrees closely with the hind wing of *S. gardineri* except that a broader wing is indicated by the greater width of both the mediastinal and scapular areas, and therefore more in accordance with the present species.

This species differs from the others in the stoutness of the wing, which is proportionally much shorter than any of the others; in keeping with this peculiarity is the greater width of both the mediastinal and scapular areas, and the more rapid descent to the margin of the termination of at least the former. In other respects the species completely resembles *S. gardineri.*

The fore wing was apparently about 15 mm. long and 7 mm. broad; the length of the fragment is 8.5 mm.

Two specimens, Nos. 19, 27.

4. Spiloblattina marginata.

Pl. 33, fig. 3.

Spiloblattina marginata Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 37.

The single specimen (with its reverse) upon which this species is founded, shows the larger and more important parts of the wing, but preserves neither the inner margin nor the tip, so that its form and proportions cannot be determined; it has, however, some marked peculiarities. The mediastinal area is relatively broad with very few, distant, oblique, simple, and nearly straight branches to the main vein, and ends very gradually after the manner of *S. gardineri*, but opposite the middle of the scapular-externomedian stigma as in *S. guttata*. The relations of the scapular to the mediastinal vein are as in *S. gardineri*, but instead of a nearly straight course opposite the stigma mentioned, it actually curves so as to encroach upon the space allotted to the stigma, and the branches, forked or simple, never compound, are distant and inequidistant; apparently the vein terminates not far above the tip of the wing. The externomedian vein is very sinuous and its longitudinal branches, sometimes compound sometimes simple, are more crowded than the others, and very inequidistant, the main vein itself almost colliding with the scapular beyond the stigma. Nothing can be determined of the internomedian or anal veins. The wing differs from the others in having its darker colors concentrated in a narrow margin to all the veins, the paler colors between them forming the real ground color to the wing.

This species is remarkable for the paucity of its neuration, and for the fact that all the veins and branches are margined with a slender dark edging. The scapular vein recedes more than usually from the costal margin opposite the very slight median stigma, and the externomedian vein is consequently more than usually curved to make place for it. The probable length of the wing was 18 mm. The inner margin being lost, the width can hardly be more than conjectured, but it was perhaps 7 mm.

One specimen, Nos. 26 and 58.

Anthracoblattina Scudder.

Anthracoblattina triassica sp. nov.

Pl. 33, fig. 9.

A single specimen and very fragmentary at that, with its reverse, is pretty plainly referable to this genus, hitherto known only from the carboniferous rocks, but it differs so much from all the known species, which are not many, that notwithstanding its imperfection I have ventured to name it. It was evidently a large fore wing, and presents a fragment from the outer half of the apex; it is hardly probable that more than a quarter of the wing appears, and only the mediastinal and scapular veins. The outer margin was very straight; the apex broadly rounded and roundly angulate externally. The mediastinal area wide at base reached to the distal sixth of the wing and had numerous simple or forked, oblique, parallel branches. The scapular vein began to fork not far beyond the middle of the wing, and itself straight and running to the tip of the wing, sent four distant and subequidistant branches to the margin, the last two simple, the first two com-

pound, the branches being scarcely more longitudinal than the mediastinal but increasingly so as the apex is gained.

The fragment, Nos. 24 and 64, is 13 mm. long and indicates a wing about 25–30 mm. long, making it much the largest of the Fairplay cockroaches. The color is a uniform dark brown.

Petrablattina Scudder.

This genus, established on forms discovered in carboniferous deposits, proves to be as well developed in the triassic rocks as in the paleozoic series.

Petrablattina aequa.

Pl. 34, fig. 13.

Petrablattina aequa Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 38.

Mediastinal vein terminating scarcely beyond the middle of the costal margin, with numerous, closely crowded, simple branches; scapular vein terminating above the tip of the wing, and beyond the basal curve nearly straight, with four or five singly forking branches; branches of externomedian vein straight, superior, mostly simple, parallel to the main scapular vein; the internomedian area extending to some distance beyond the middle of the wing. It is a tolerably large species, the wing measuring 24 mm. in length and 10 mm. in breadth.

Four specimens were obtained, one however showing nothing but the anal area, Nos. 20, 61, 62, 63.

Petrablattina meieri.

Pl. 34, fig. 17.

Petrablattina meieri Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 38.

Mediastinal vein terminating a long way beyond the middle of the costal border, with comparatively distant, usually simple branches. Scapular vein terminating just below the tip of the wing and beyond the basal curve, gently arcuate throughout, with branches similar to those of *P. aequa*, but occupying a larger area. In consequence, the externomedian area is of less importance than in *P. aequa*, and it has but few branches, which appear to be generally simple, and slightly declivent, though superior. Unfortunately this portion of the wing in the single specimen known is very obscure. The internomedian vein is not preserved in its outer portion, but it evidently reached the border nearer the base than the mediastinal vein, and the anal furrow is strongly curved. The wing is broken at the base, but its probable length was 19 mm., and its breadth, 7mm. It is named after Mr. Robert A. Meier, of Garo, Col., in whose shaft all these specimens were obtained, and who afforded our party all possible assistance in working them.

A single specimen was secured, No. 25.

Poroblattina Scudder.

Poroblattina Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 38–39.

Allied to Petroblattina, and especially the species of that genus found in the same Triassic rocks, differing from them principally in the insignificant part played by the mediastinal area and the corresponding importance of the scapular area. The mediastinal vein extends no further out than the anal, terminating far before the middle of the wing, and has consequently but a few offshoots; while the mediastinal, sweeping downward, away from the costal margin at the termination of the mediastinal, occupies nearly half of the wing before curving upward again to terminate above the apex. The externomedian vein is arcuate and terminates on the lower margin not far from the tip, and has only three or four superior longitudinal branches. The anal furrow is strongly arcuate. The anal veins are nearly parallel to the inner margin, but impinge upon it near the anal furrow.

This genus is peculiar to Fairplay and two species are known.

TABLE OF THE SPECIES OF POROBLATTINA.

Scapular vein strongly sinuous, the proximal series of branches simple	1. P. arcuata.
Scapular vein gently sinuous, the proximal series of branches deeply forked	2. P. lakesii.

1. Poroblattina arcuata.

Pl. 33, fig. 5.

Poroblattina arcuata Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 39.

The costal border is considerably convex. The scapular vein is unusually arcuate and has a large number of mostly simple oblique branches. The externo- and internomedian veins, on the contrary, have few and distant branches, and the former is also strongly arcuate. The whole surface of the wing is broken by closely crowded cross-veins, which are more transverse to the whole wing than to the interspaces.

Length of fragment, 5.5 mm.; probable length of wing, 10 mm.; breadth, 4 mm.

A single rather imperfect specimen was obtained, No. 47, indicating a wing well rounded and much shorter in proportion to its breadth than in the next species.

2. Poroblattina lakesii.

Pl. 33, fig. 11.

Poroblattina lakesii Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 39.

The costal border is nearly straight and the wing elongate. The scapular vein is much less arcuate than in the preceding species and has a comparatively small number of distant, singly or doubly forked, oblique branches. The much less oblique branches of the internomedian vein are more frequent but appear less crowded from their simplicity, while those of the externomedian are more distant than the latter, and equally simple. There is no sign of any cross-venation.

Two specimens, Nos. 30, 73 and 74. This species like the preceding, is small, the wing measuring about 12 mm. long, and 4.5 mm. broad. Named after Prof. Arthur Lakes of the School of Mines at Golden, Colorado, the first discoverer of these fossils.

BLATTARIAE Latreille.

NEORTHROBLATTINA Scudder.

Neorthroblattina Scudd., Proc. Nat. Sc. Philad., 1885, 108–109.

In this genus the wings are about two and a half times longer than broad, with fairly well rounded apices, the mediastinal and scapular veins amalgamated into a single vein, which extends nearly to the tip and in the middle of the wing occupies nearly one-half its width. The internomedian vein is of varying importance, and in the large anal area the veinlets terminate on the margin; the anal furrow is strongly arcuate, and deeply impressed.

All the species are small. *N. lakesii* may be taken as the type.

TABLE OF THE SPECIES OF NEORTHROBLATTINA.

Fore wings not more than two and a half times as long as broad; mediastino-scapular vein terminating only a little before the tip of the wing.

Internomedian vein beginning to fork long before externomedian and of equal importance with it. **1. N. albolineata.**

Internomedian vein beginning to fork scarcely or not before the externomedian and of less importance than it.

Internomedian area terminating much farther from the apex of the wing than the mediastino-scapular. **2. N. lakesii.**

Internomedian area reaching out toward the apex of the wing nearly as far as the mediastino-scapular. **3. N. rotundata.**

Fore wings about three times as long as broad; mediastino-scapular area terminating long before the tip of the wing. **4. N. attenuata.**

1. Neorthroblattina albolineata.

Pl. 34, figs. 2, 18.

Neorthroblattina albolineata Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 109.

The single wing has lost the tip, but all the essential features are preserved, excepting the form of the tip. The wing is very dark colored, and the veins appear as very pale lines upon it. The costal margin is gently and equably arched, while the inner margin is perfectly straight. The externomedian vein is little developed, first forking and then not widely in the middle of the wing, its fuller development being prevented by the ample and unrestricted development of the internomedian vein, which runs in a full rounded course nearly to the tip of the wing. The anal area is interesting because the veins of the upper half run close to, but do not impinge upon the anal furrow, curving downward just before reaching it, and either running into the next vein below and terminating there, or continuing parallel to the furrow and terminating on the inner border.

A single prothoracic shield has been found which I have referred here. It is broadly transversely oval, considerably domed, highest in a vague, transverse, median ridge, the anterior curve indistinctly bent in the middle (not so shown on the plate), the posterior curve broad and in the middle somewhat flattened; the sides are well rounded and the whole is about a fourth broader than long, all the margins entire.

Length of fragment of wing, 7 mm.; probable length of wing, 9 mm.; breadth, 3.5 mm.; length of prothoracic shield, 3.5 mm.; breadth, 4.3 mm.

Two specimens, Nos. 32, 33.

3. Neorthroblattina lakesii.

Pl. 34, figs. 9, 15.

Neorthroblattina lakesii Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 109.

The costal margin is arched as in the last species, and the inner margin has an almost equal opposite curvature. The externomedian vein has a very sinuous course, and forks before the middle of the wing with abundant neuration, occupying on the margin the entire tip of the wing, and almost the outer half of the lower margin, while the internomedian is reduced to an arching vein, extending but little beyond the anal furrow, and with only two or three branches; the anal veins are all parallel to the anal furrow and simple.

A single stone with its reverse shows the prothoracic shield, which is broadly and transversely oval, a little more than a fifth broader than long, tolerably regular, with very broad sides, the anterior margin scarcely bent in the middle, the curve of the hind margin somewhat flattened; uniformly and rather strongly domed, the lateral margins a little flattened, and with a median, slight, but rather abrupt and pretty large, rounded depression.

Length of fore wing, 9 mm.; breadth, 3.5 mm.; length of prothoracic shield, 3 mm.; breadth, 3.65 mm.

Two wings, one of them with its reverse, and one shield with its reverse, were found, Nos. 34, 35 and 82, 76 and 77. Named after Prof. Arthur Lakes of the School of Mines in Golden, Colorado, who first made known these beds, this species being one of the first discovered by him.

3. Neorthroblattina rotundata.

Pl. 34, figs. 7, 8.

Neorthroblattina rotundata Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 109-110.

The costal margin in this species is very strongly arched, while the inner margin is straight, giving a very different aspect to the wing. It closely resembles the preceding species in the mediastino-scapular and anal areas, and also in the peculiarities of the externomedian vein, excepting that the latter does not encroach to so large a degree upon the internomedian, the terminal offshoot of which creeps along the border so as to limit the marginal extent of the externomedian area almost as much below as above, although the branching of the externomedian vein is scarcely lessened thereby.

Length of wing, 8.5 mm.; breadth, 3.3 mm.

Three specimens, all with reverses, Nos. 78 and 79, 100 and 101, 102 and 103.

4. Neorthroblattina attenuata.

Pl. 34, fig. 1.

Neorthroblattina attenuata Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 110.

This species departs from the typical forms in its slenderness and pointed apex, but it agrees so fairly in general structure that it would best be placed here. The costal margin is not regularly arched, being flattened mesially, while the whole wing tapers regularly in the apical half; the inner margin is also arcuate, and the tip bluntly pointed. The

mediastino-scapular vein terminates considerably before the apex, and the oppositely arcuate internomedian reaches almost as far out, the branches of both nearly always simple. The anal veins are only slightly irregular.

Length of wing, 12 mm.; breadth, 4 mm.

A single specimen with its reverse, Nos. 31 and 75.

Scutinoblattina Scudder.

Scutinoblattina Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 110.

In this genus, composed of small species, the front wings are decidedly more coriaceous than the hind wings, so that the neuration is often more or less obscured by it. The wing itself is convex, as in the modern Phoraspis, and subtriangular in form, its greatest width being near the base, while the tip is bluntly pointed. The mediastinal and scapular veins are again blended into one which, instead of having a sinuous course, is nearly or quite straight and terminates below the apex of the wing, while the externomedian vein follows closely parallel to it, and the oblique veins of this and the internomedian veins follow each other so as to make it difficult to tell where the line of demarcation may lie. The anal veins sometimes fall on the margin and sometimes on the anal furrow. *Scutinoblattina brongniarti* may be regarded as the type of this group.

TABLE OF THE SPECIES OF SCUTINOBLATTINA.

Mediastino-scapular and externomedian veins having a distinctly sinuous course through the middle of the wing, both terminating below the apex.	
Anal branches falling on the hind margin	**1. S. brongniarti.**
Anal branches falling on the anal furrow	**2. S. intermedia.**
Mediastino-scapular and externomedian veins taking a straight course through the middle of the wing, both terminating at the tip	**3. S. recta.**

1. Scutinoblattina brongniarti.

Pl. 34, fig. 5.

Scutinoblattina brongniarti Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 110-111.

In this interesting species the wings are very strongly convex at the base, and the whole surface is flecked with dark spots. The branches part from the main veins at a similar angle on either side of the middle of the wing. The anal area extends nearly to the middle of the wing, where it is marked by a considerable emargination, and its veins are frequent, oblique, mostly simple, and terminate on the margin.

One of the specimens shows also a portion of the hind wings and most of the prothorax. The former were longer and considerably broader than the fore wings, but no essential part of the neuration can be traced. The prothorax was transversely ovate, a little angulate at the sides, strongly domed, and either the head or an impression of much the shape and size of a head, about half the width of the prothoracic shield, can be seen lying on the anterior half of the latter.

Length of fore wing, 7 mm.; breadth, 3 mm.; length of prothoracic shield, 2 mm., breadth, 3 mm.

Two specimens, one with reverse, Nos. 36, 80 and 81. Named after Mr. Charles Brongniart of Paris, well known for his remarkable discoveries among the older fossil insects.

2. Scutinoblattina intermedia.

Pl. 34, fig. 4.

Scutinoblattina intermedia Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 111.

This species resembles the last, but is not marked by any dots, and the anal area, while shorter, shows no emargination of the border at its extremity; the anal veins are very close, parallel to the inner margin, and terminate not on the margin, but on the anal furrow. It further differs in that the externomedian branches are considerably more longitudinal than those terminating on the costal margin.

Length of wing, 7 mm.; breadth, 2.75 mm.

Two specimens, one with its reverse, Nos. 97 and 98, 99.

3. Scutinoblattina recta.

Pl. 34, figs. 3, 16.

Scutinoblattina recta Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 111.

This species, the smallest and most abundant of all in the triassic rocks, is rather slenderer than the others, and has the surface finely reticulated. The mediastino-scapular and externomedian veins run side by side in perfectly straight lines from the middle of the base to the middle of the tip, the branches, very few in number, parting similarly on the two sides. The costal is more arched than the inner margin, and where they can be made out, the one or two anal veins seem to run to the margin, but all the veins on the wing are exceedingly obscure.

A couple of stones, one with its reverse, show the prothoracic shield to have been very nearly circular, slightly broader than long, scarcely more produced in front than behind, uniformly and considerably domed, the margins entire and in no way displayed.

Length of wing, 6.3 mm.; breadth, 2.4 mm.; length of prothoracic shield, 2.9 mm.; breadth, 3.1 mm.

Four wings have been found, three of them with reverses, Nos. 37, 85 and 86, 87 and 88, 89 and 90, besides two prothoracic shields, one with its reverse, Nos. 38 and 84, 83.

HEMIPTERA.

Cercopidae Leach.

The remaining insects appear to fall in this group of homopterous insects.

Cercopyllis (dim. of *Cercopis*) gen. nov.

Under this name are grouped the very few insect forms found in these beds which are not cockroaches. They are very small and appear to be quite unlike anything found in mesozoic or older deposits. Hardly anything besides wings are known, and these in all cases fore-wings with extremely simple neuration, consisting of a simple radial vein

terminating in the distal half of the wing after an abrupt bend, an ulnar vein with only a very few branches not connected by cross veins, and one or two simple or simply forked veins in the anal area of the wing.

Cercopyllis justiciae sp. nov.

Pl. 34, fig. 6.

A small stout-bodied insect with a tapering abdomen, divided uniformly into joints and with a somewhat pointed tip. The fore-wing extends a long way beyond the tip of the abdomen, which indeed only reaches its middle, is moderately broad with a strongly and regularly convex costa; the apex is lost, but the curve gives a certain definiteness to the probable length of the wing, so that the radial vein may be said to terminate at the end of its middle third; this vein runs completely parallel to and at a moderate distance from the margin until close to its termination, when it bends abruptly as if to form an ovate stigma and passes obliquely to the margin. The ulnar vein forks thrice subequidistantly, the last time opposite the bend of the radial vein, to the oblique end of which its final branch is parallel; the first fork is a little nearer to the base of the wing than to the last fork, and the vein is rather distant from the radial vein; all the branches are simple, distant, nearly straight, and unconnected by cross veins. Within these are two other simple veins, parallel to the inner ulnar branch, the one next it perhaps the sutura clavi.

Length of (headless) body, 4.4 mm.; breadth of thorax, 2.2 mm.; length of fragment of wing, 5 mm.; probable complete length, 5.4 mm.; probable breadth, 2.1 mm.

A single specimen and its reverse, No. 39.

Cercopyllis delicatula sp. nov.

Pl. 34, fig. 11.

A nearly complete fore-wing unfortunately with the base very obscure. It is about two and a half times longer than broad, broadest in the apical half toward which it increases very slowly in size, tapering more rapidly, the apex well rounded, the upper and lower halves nearly symmetrical, the costal margin nearly straight to the end of the radial vein. The radial vein is very similar to that of the preceding species, but if anything is a little longer. The ulnar vein has the same number of branches, but arising at very unequal distances and so of very unequal lengths, the first and second near together, well within the basal half of the wing, the outer quite as in the preceding species, though a little farther removed from the oblique portion of the radial vein. The vein next within the inner ulnar vein (the sutura clavi?) is straight and not, as shown on the plate, arcuate, and the one within that shows some signs of simple inferior branches. Veins and membrane alike are seen under a half-inch objective to be uniformly clothed with excessively fine hairs, as far apart as their own length (which does not exceed 0.017 mm.), directed outward, with a tendency to run in lines.

Length of wing, 5.2 mm.; breadth, 2 mm.

One specimen and its reverse, No. 40.

Cercopyllis adolescens.

Pl. 34, fig. 12.

A single fragment of the tip of a wing which resembles *C. justiciae* rather than the last species, but in size agrees better with the latter and has the same apical curve. The radial vein comes much nearer to the tip of the wing than in either of the others, and has a decided curve in opposition to the costa just before the final bend. From what can be seen of the ulnar vein, it would seem to be constructed as in the others, but the final fork is earlier and its relation to the preceding and to the oblique end of the radial vein more as in *C. justiciae* than as in *C. delicatula*. Nothing of the other veins can be seen. The membrane and veins are clothed precisely as in *C. delicatula*, though less distinctly, and the hairs appear to be shorter (perhaps more erect) and if anything more distant.

Length of fragment, 3.2 mm.; breadth, 1.4 mm.

One specimen, No. 41.

EXPLANATION OF PLATES.

PLATE 33.

All the drawings are by Mrs. Katherine Peirson Ramsay and are magnified ⅘.

Fig. 1. *Spiloblattina triassica.*
Fig. 2. *Spiloblattina guttata.*
Fig. 3. *Spiloblattina marginata.*
Fig. 4. *Spiloblattina gardineri;* hind wing.
Fig. 5. *Poroblattina arcuata.*
Fig. 6. *Spiloblattina gardineri.*
Fig. 7. *Etoblattina persistens.*
Fig. 8. *Spiloblattina gardineri.*
Fig. 9. *Anthracoblattina triassica.*
Fig. 10. *Spiloblattina gardineri.*
Fig. 11. *Poroblattina lakesii.*

PLATE 34.

The drawings as on the preceding plate.

Fig. 1. *Neorthroblattina attenuata.*
Fig. 2. *Neorthroblattina albolineata.*
Fig. 3. *Scutinoblattina recta.*
Fig. 4. *Scutinoblattina intermedia.*
Fig. 5. *Scutinoblattina brongniarti.*
Fig. 6. *Cercopyllis justiciae.*
Fig. 7. *Neorthroblattina rotundata.*
Fig. 8. *The same.*
Fig. 9. *Neorthroblattina lakesii.*
Fig. 10. *Etoblattina persistens.*
Fig. 11. *Cercopyllis delicatula.*
Fig. 12. *Cercopyllis adolescens.*
Fig. 13. *Permoblattina aequa.*
Fig. 14. *Spiloblattina guttata;* hind wing.
Fig. 15. *Neorthroblattina lakesii;* prothoracic shield.
Fig. 16. *Scutinoblattina recta;* prothoracic shield.
Fig. 17. *Permoblattina meieri.*
Fig. 18. *Neorthroblattina albolineata;* prothoracic shield.
Fig. 19. *Etoblattina persistens;* prothoracic shield.
Fig. 20. *Etoblattina* sp.

Bibliographical Note on American Literature treating of the Older Fossil Insects.

Fossil insects have not been a favorite study with American naturalists, and the foregoing pages include so nearly everything that has been written in this country upon the pretertiary species that I have thought it worth while to make it still more complete by supplying references to what other material existed in a printed form.

The earliest reference to any pretertiary insect in this country is that of Dr. Edward Hitchcock in 1858 to Mormolucoides. His and subsequent opinions of other naturalists upon that larva will be found given above on p. 323. In the following year, Dr. (now Sir William) Dawson published his interesting discovery of myriapods in the sigillarian stumps of Nova Scotia (Quart. journ. geol. soc. Lond., xvi: 271–273, figs. 4–9; Can. nat. geol., viii: 280, pl. 6), and in 1860, Lesquereux described a cockroach from the carboniferous beds of Arkansas (Rep. geol. Ark., ii: 314, pl. 5). The more important papers were those which followed within a few years by Prof. J. D. Dana and Messrs. Meek and Worthen. The former published descriptions of two neuropteroid types of insects, the first known in this country from the carboniferous rocks (Amer. journ. sc. arts, [2], xxxvii: 34–35, figs.), which first drew my own attention to fossil insects. The latter, first in serial literature (Proc. acad. nat. sc. Philad., 1865: 41–53; Amer. journ. sc. arts, [2], xlvi: 19–28), afterwards in the report of the Geological Survey of Illinois (ii: 410–411, pl. 32, fig. 3; iii: 540–565, figs.), describe and figure several myriapods and arachnids from the carboniferous rocks of the prolific deposits at Mazon Creek, Ill. Later descriptions have been those of Paolia in 1871 by S. I. Smith (Amer. journ. sc. arts, [3], i: 44–46, fig.); of Arthrolycosa in 1874 by Harger (Ibid., [3], vii: 219–223, fig.), recently restudied by Beecher (Ibid., [3], xxxviii: 219–223, fig.); of Proscorpius from the New York silurian rocks in 1885 by Whitfield (Science, vi: 87–88, fig.; Bull. Amer. mus. nat. hist., i: 181–196, pl. 19, 20), the subject of some contention on the part of the author and Dr. Thorell (Amer. nat., xx; 269–274; Science, vii: 216–217); and of a highly interesting find in the Devonian of New Brunswick by Matthew in 1889 (Trans. roy. soc. Can., 1888, iv: 49–62, pl. 4).

A few minor notices may be alluded to. Clark records the discovery of a cockroach in the Rhode Island coalfield (Proc. Newp. nat. hist. soc., ii: 9–12); James regards the carboniferous Rhizomorpha an insect-burrow (Journ. Cinc. soc. nat. hist., viii: 157–159); and Hagen and Chambers have somewhat to say regarding the occurrence of galls, etc., on the vegetable remains of the Dacotah group (Nature, xxv: 265–266, 529). Besides these are some critical papers by Hagen on the Devonian insects of New Brunswick (Nature, xxiii: 483–484; xxiv: 356–357; xxxii: 53–54; Bull. mus. comp. zool.,

VIII: 275–284; Zool. anz., VIII: 296–301), and by Packard on the carboniferous myriapods (Proc. Amer. phil. soc., XXI: 197–209, figs.; Amer. nat., XVII: 326–329). Reference may also be made to Lesley's Dictionary of the fossils of Pennsylvania (Rep. Geol. surv. Penns., P[4]) in which figures of many of our species are copied, and of Miller's North American geology and paleontology (Cincinnati, 1889) in which a few are also re-figured; to Lacoe's list of the paleozoic fossil insects of the United States and Canada (Publ. 5, Wyom. hist. geol. soc.), complete up to the date of its publication in 1883; and to the excellent bibliographies of White and Marcou in the American naturalist and elsewhere.

It may be worth while to add that tracks upon American triassic rocks referred to insects were first mentioned by Warren in a separate publication on footprints (Boston, 1854), next by Deane (Journ. acad. nat. sc. Philad., [2], III: 177, pl. 19), then by Emmons (Amer. geol., VI: 136, pl. 13), and lastly by E. Hitchcock, who in his Ichnology (Boston, 1858) and supplement thereto (Boston, 1865), figured more than all the others together. A list of them was subsequently published by C. H. Hitchcock in Walling and Gray's Atlas of Massachusetts (1871).

My own contributions are principally embodied in the present volume, the table of contents to which shows where they were originally published. Yet as there are some others, issued elsewhere, and the results elaborated in the present memoirs were sometimes given in abstract or epitome at an earlier or even date in some other place, it may be well to note them briefly.

The first of all, a brief notice of the highly interesting Devonian insect-fauna of New Brunswick, was published in 1865 in Bailey's Observations on the geology of southern New Brunswick, published by order of the House of Assembly. Descriptions of several Canadian carboniferous insects will be found in Dawson's Acadian geology, 2d ed., 386–388, 524–526, figs. 153, 181–184, London, 1868 (see also Can. nat., n. s., III: 202–206, figs.). Descriptions of Megathentomum and Archegogryllus were also given in 1868 (Proc. Bost. soc. nat. hist., XI: 401–403; Amer. journ. sc. arts, [2], XLVI: 419–421), as well as of a number of new carboniferous insects from Mazon Creek (Geol. surv. Ill., III: 566–572); two cockroaches from Cape Breton in 1874 (Can. nat., n. s., VII: 271–272, figs.); other carboniferous insects from the same in 1875 (Proc. Bost. soc. nat. hist., XVIII: 113–114; Proc. Amer. assoc. adv. sc., XXIV: B, 110–111, figs.; Can. nat., n. s., VIII: 88–90, figs.); a list of American paleozoic insects in 1876 (Geol. mag., [2], III: 519–520), and a brief comparison of the carboniferous insect-fauna of Europe and America in the same year (Proc. Bost. soc. nat. hist., XVIII: 358–359); descriptions of single carboniferous insects or supposed insects in 1878 (Proc. Bost. soc. nat. hist., XIX: 238–239, 248–249, 300–301); of a single carboniferous cockroach from Virginia in 1880 (Rep. geol. surv. Penns., PP, 104); of two British carboniferous insects in 1881 (Geol. mag., [2], VIII: 293–300, fig.; Harv. univ. bull., II: 175), with a note on Lithosialis (Proc. Bost. soc. nat. hist., XXI: 167); a description of an Etoblattina in 1882 (Ibid., XXI: 391–396); in 1883, notes on a carboniferous hemipterous insect from Kansas, and of triassic insects in Colorado (Ibid., XXII: 58–60), further notes on sigillarian insects from Nova Scotia (Phil. trans., 1882: 649–650), and a notice of Protophasma (Science, I: 95–96, fig.); a revision of paleozoic Arachnida with descriptions of new forms was given in

1884 (Proc. Amer. acad. arts sc., xx: 13–22); in 1885, a similar revision of the Protophasmida (Ibid., xx: 167–173), together with descriptions of new carboniferous and triassic cockroaches (Proc. acad. nat. sc. Philad., 1885: 34–39), and of mesozoic cockroaches (Ibid., 1885: 105–115); also descriptions of two English carboniferous insects (Geol. mag., [3], II: 265–266), a general review of the geological history of myriapods and arachnids (Psyche, IV: 245–250), and a note on Anthracomartus (Comptes rend. soc. ent. Belg., [3], No. 62); a general review of fossil cockroaches was published in Miall's work on the cockroach (London, 1886); a brief note on some British carboniferous cockroaches was all that appeared in 1887 (Proc. Bost. soc. nat. hist., XXIII: 356–357); and in 1889, descriptions were published of the Palaeoblattariae of Richmond, Ohio (Ibid., XXIV: 45–53).

The first paper in the present volume was preceded by a digest of its conclusions a year earlier (Amer. journ. sc. arts, [2], XL: 269–271). So that on Early types of insects was preceded by a similar general summary (Ibid., [3], XVII: 72–74; Kosmos, V: 61–62); as also that on the Devonian insects (Amer. journ. sc. arts, [3], XXI: 111; Ann. mag. nat. hist., [5], VII: 255–261); on Archipolypoda (Amer. journ. sc. arts, [3], XXI: 182–186); on Diverse types of myriapods (Ibid., [3], XXVI: 161–170); and on the Triassic insects (Ibid., [3], XXVIII: 199–203).

In addition, besides a bibliography of fossil insects in general (Cambridge, 1882[1]) and a review of the advance made in this division of the paleontological field during the last decade (Psyche, V: 287–295), the author has published several general accounts of fossil insects: the earlier, very brief and summary, and concerning North America only (Amer. nat., I: 625–631, pl. 16; Geol. mag., V: 172–177, 216–222), the later giving a systematic survey of the entire field, published in German in Zittel's Handbuch der palaeontologie, I, th. II: 721–831, with numerous illustrations (München, 1885, French ed., 1886), and in English, with slightly fuller text and no illustrations, as Bulletin 31 of the U. S. Geological Survey.

ERRATA.

Page 1, line 2, *for* on the wings, *read* in the wings.
Page 5, 5th line from bottom, *for* two-thirds, *read* one-third.
Page 88, line 5 and note 2, *for* Archimantis, *read* Lithomantis.
Page 89, line 15, *for* Ledrophora *read* Legnophora.
Page 88, line 20, *for* internomedian, *read* externomedian.
Page 159, centre heading, *for* figs. 5, 9, 10, *read* figs. 9, 10.
" " 7th line from bottom, *for* 23, *read* 235.
Page 185, 9th line from bottom, *for* confidentially, *read* confidently.
Page 202, line 19, *for* arrayed, *read* arranged.
Page 223, line 2, *for* figs. 10, 18, *read* figs. 16–18.
Page 277. The figure is very poorly printed; all the apical margin beyond the longitudinal veins should be dotted.
Page 287, last line but one, *for* Palephemera, *read* Platephemera.
" " last line, *for* Runswick, *read* Brunswick.
Page 301, line 5, *for* στέφω, read στρέφω.
Page 311, in centre, *for* Meganthentomum, *read* Megathentomum.
Page 321, line 31, *for* non existing, *read* now existing.
Page 333, 8th line from bottom, *for* size, *read* length.
Page 371, 3d line from bottom, *for* fig. 6, *read* fig. 18.
Page 408, line 25, *for* punctae, *read* puncta.

[1] A new edition of this is now in press, to be published by the U. S. Geological Survey (Bull. 69).

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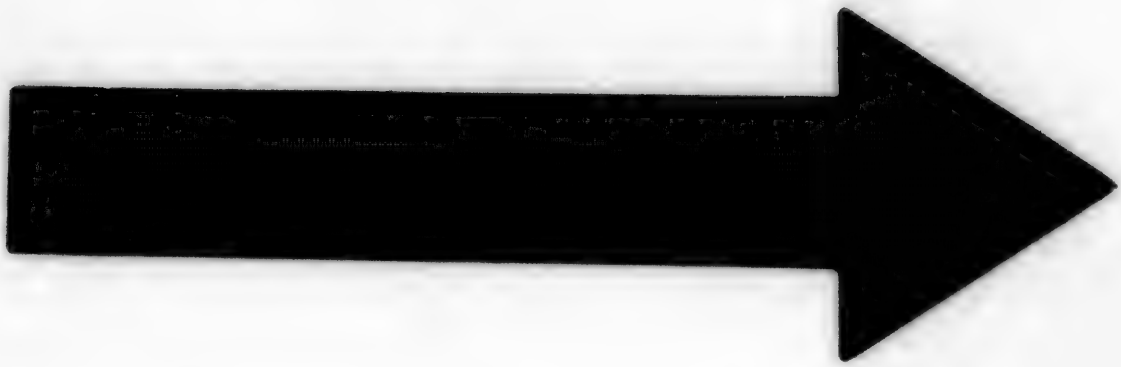

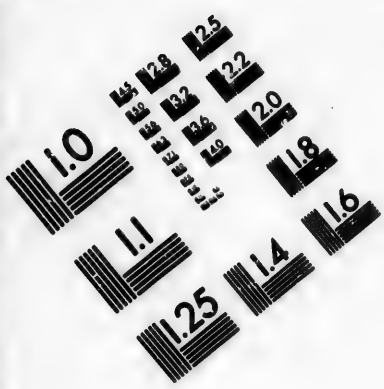

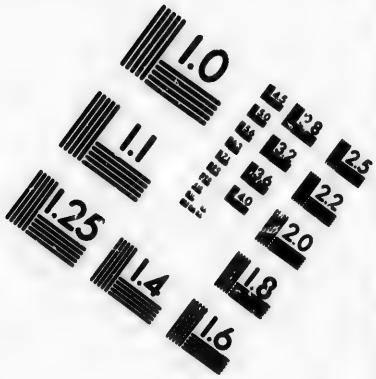

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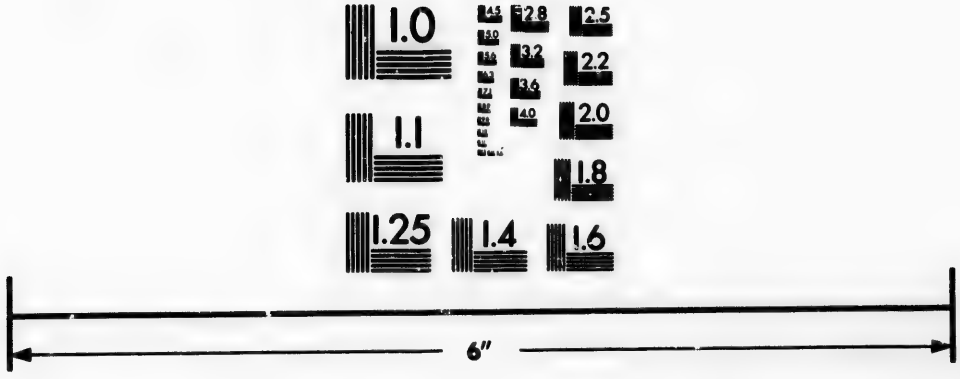

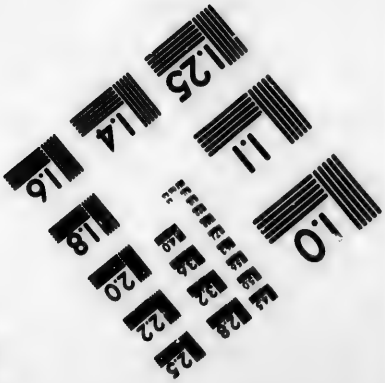

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Fig. 1

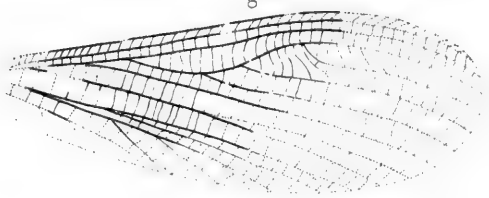


Fig. 2

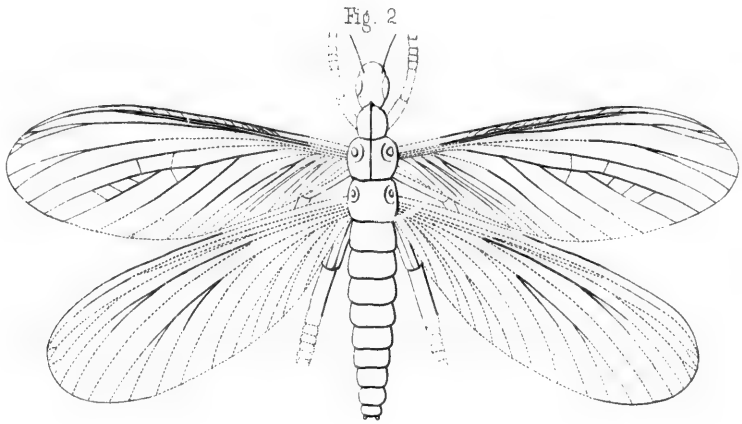


Fig. 3

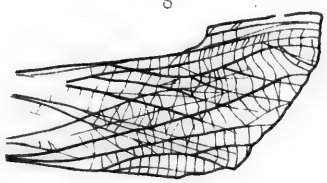
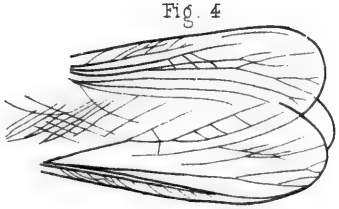


Fig. 4



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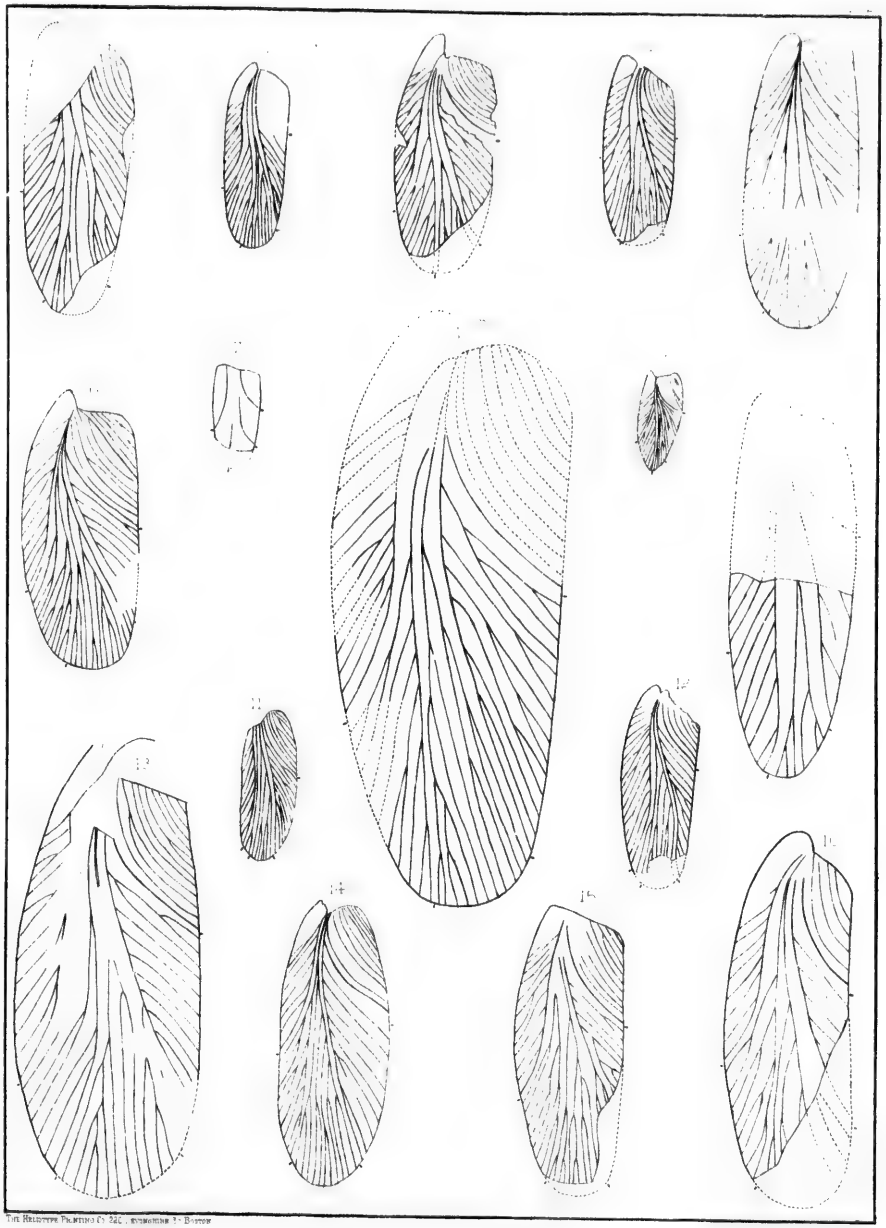
Scudder on the Wings of fossil Neuroptera



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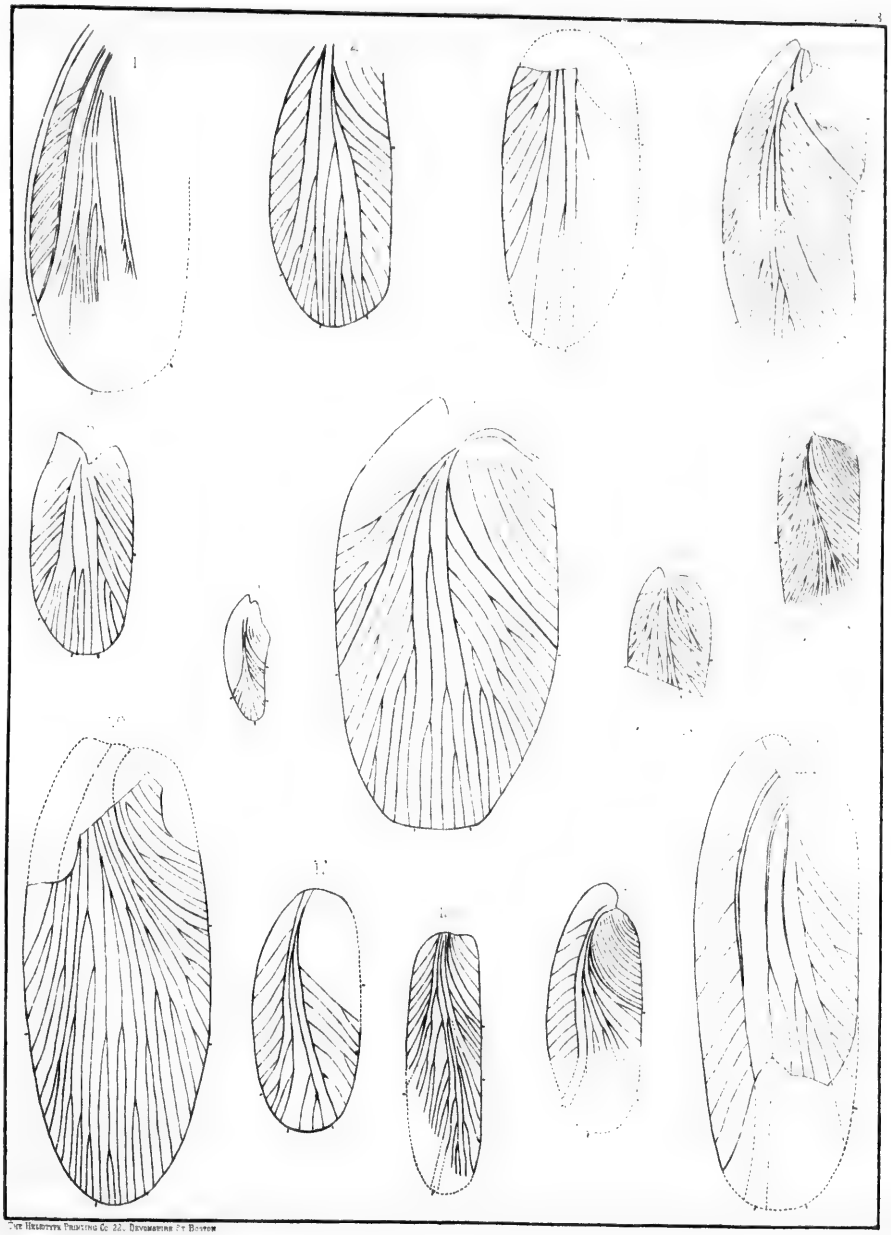

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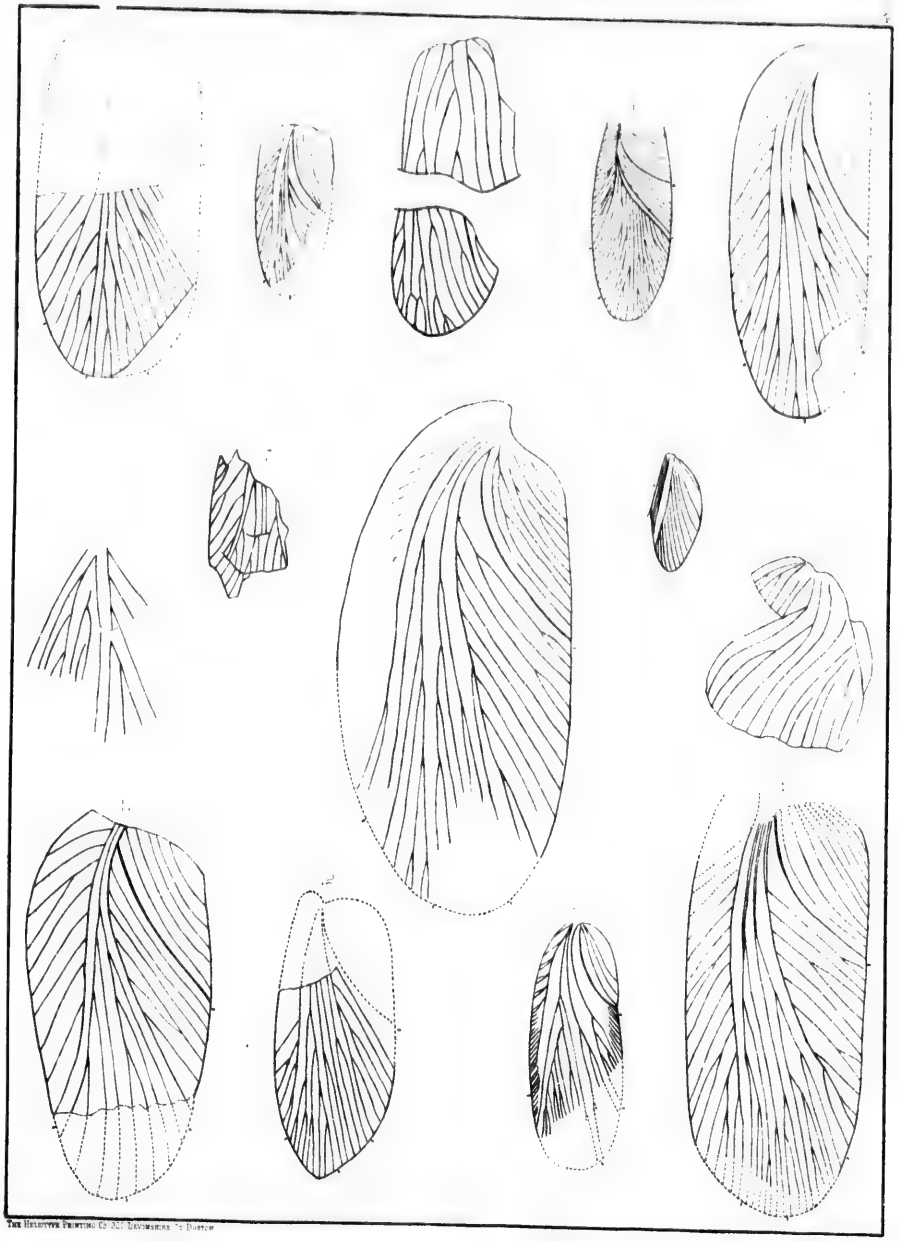

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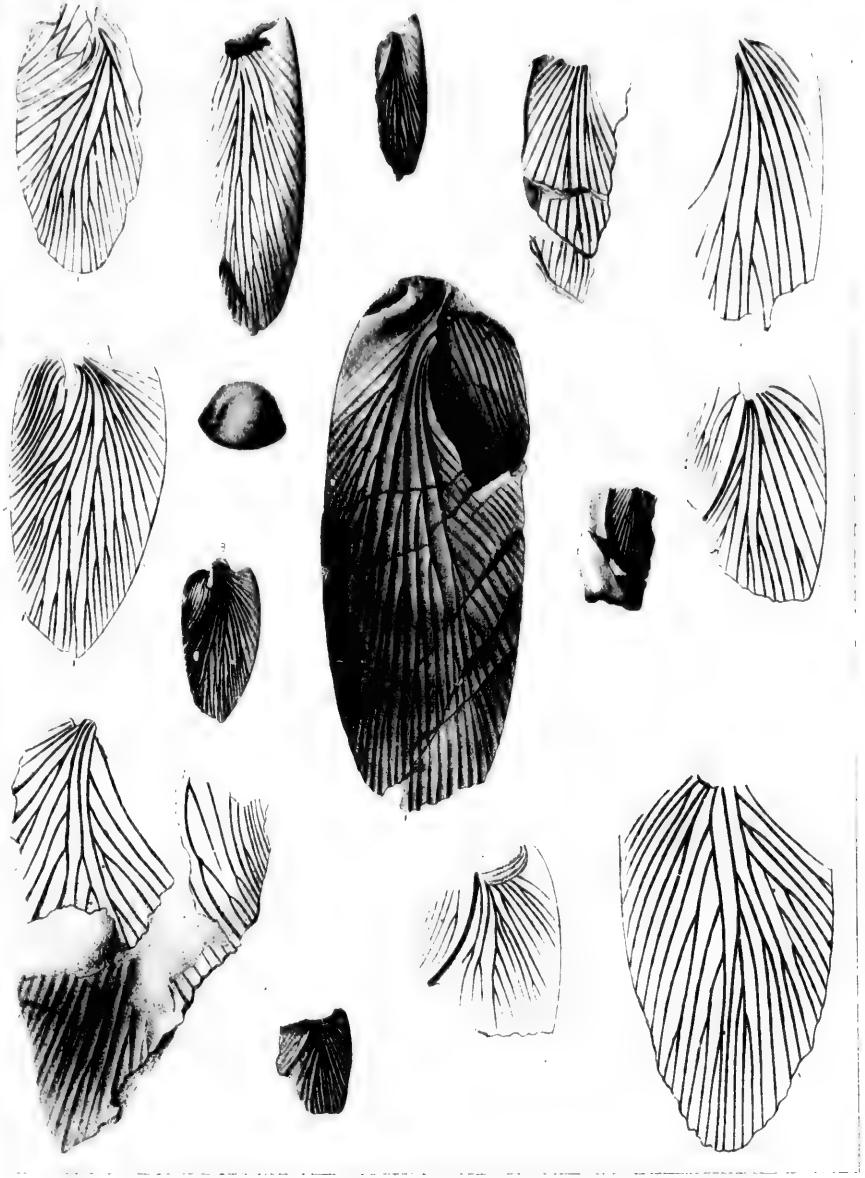

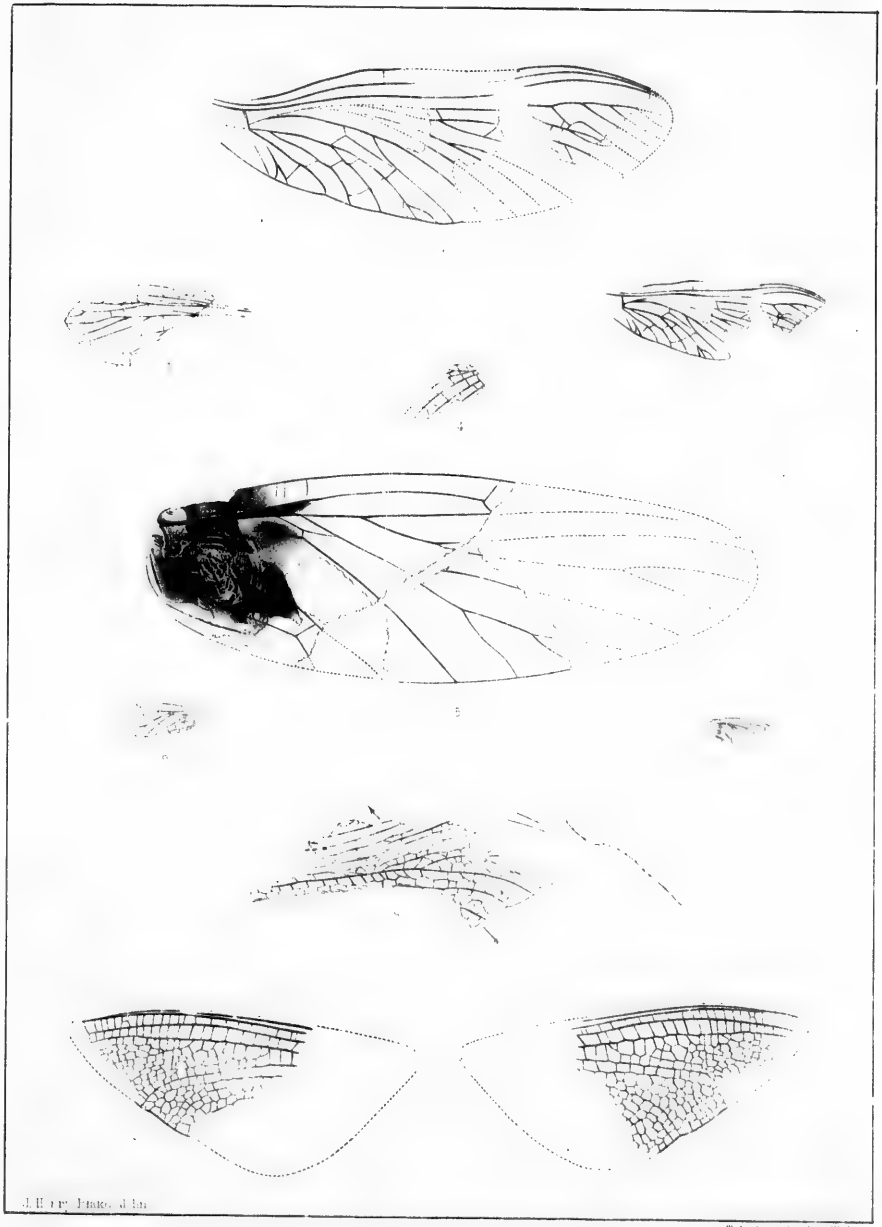

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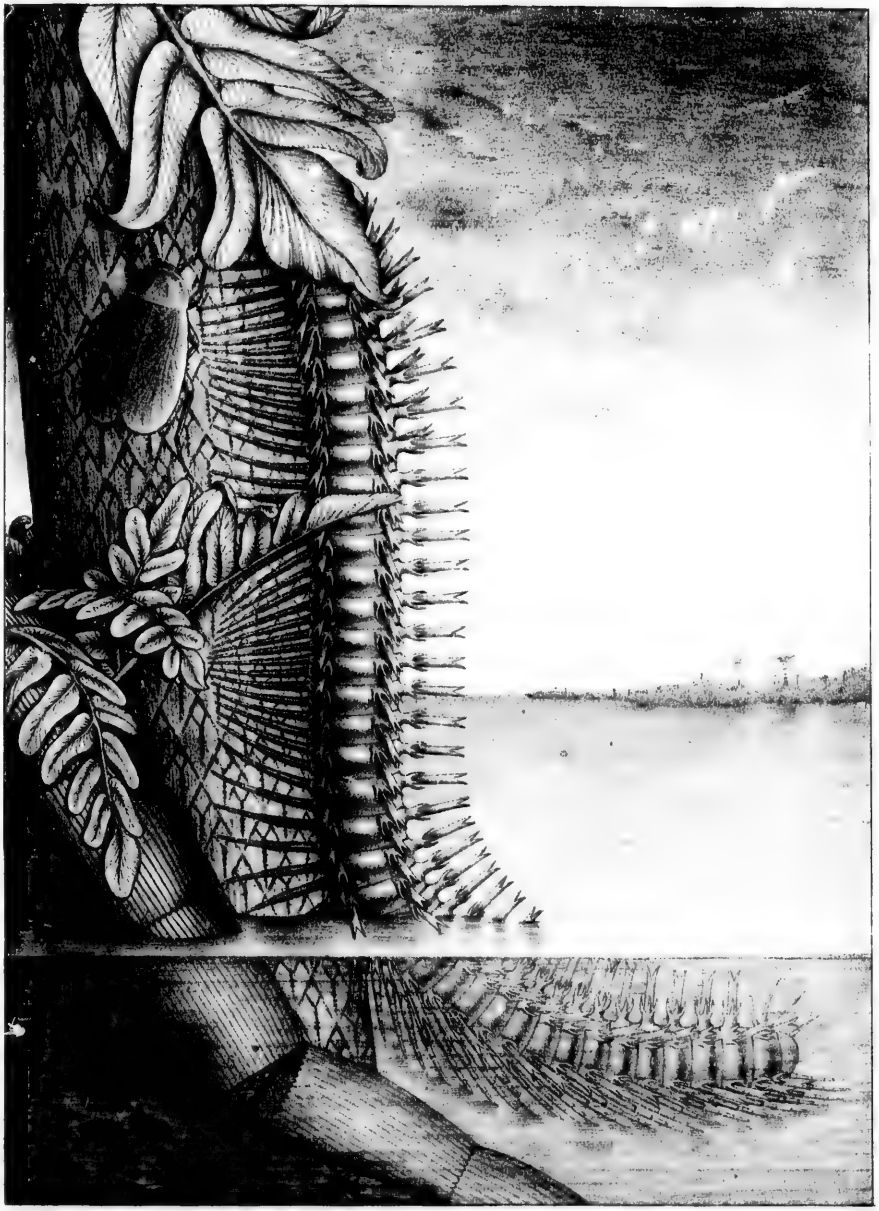

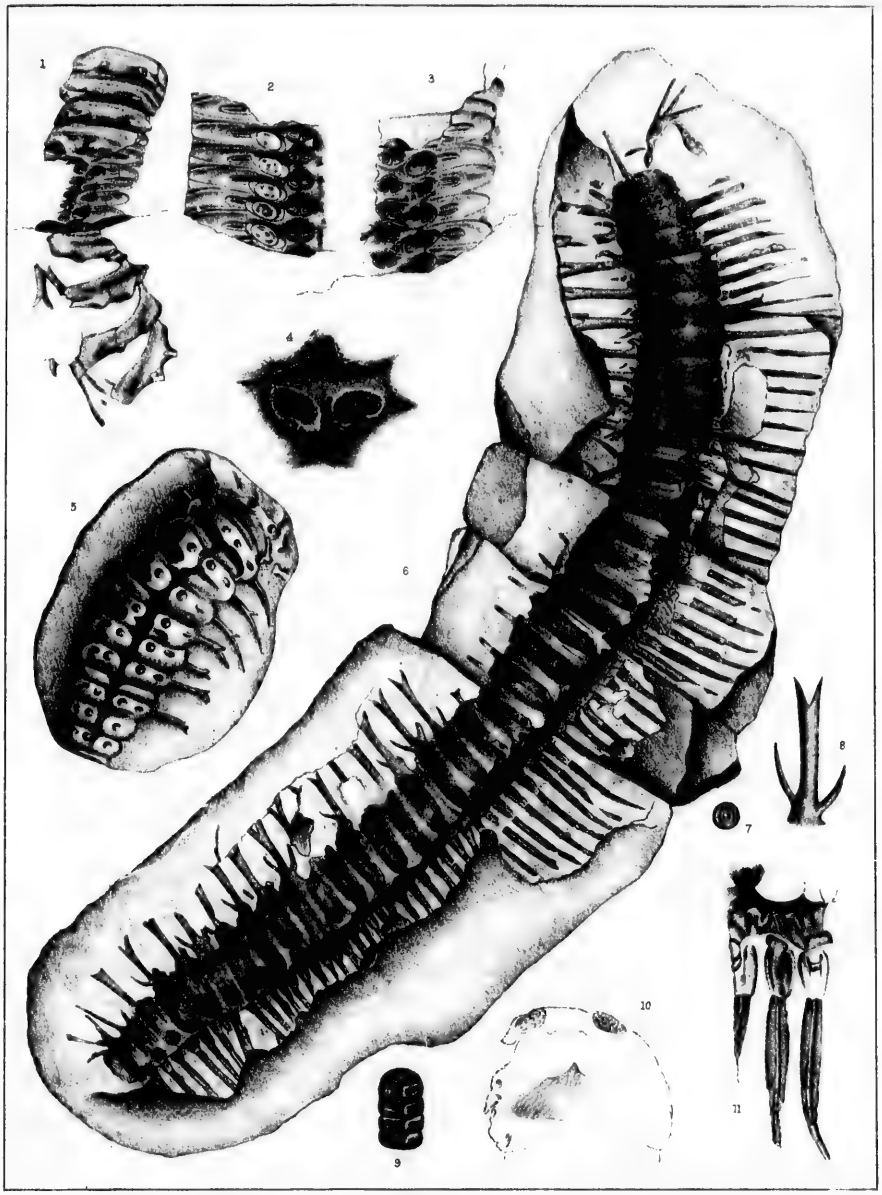
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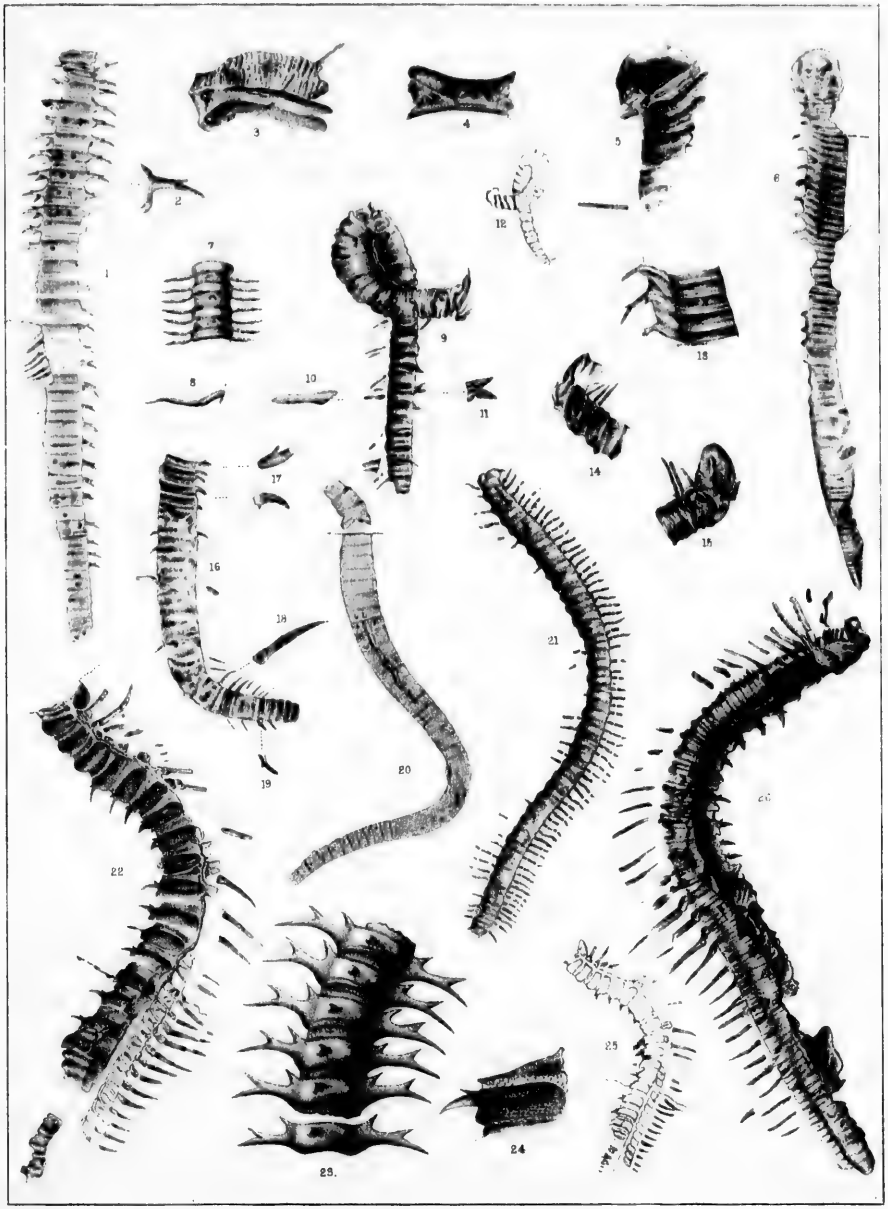
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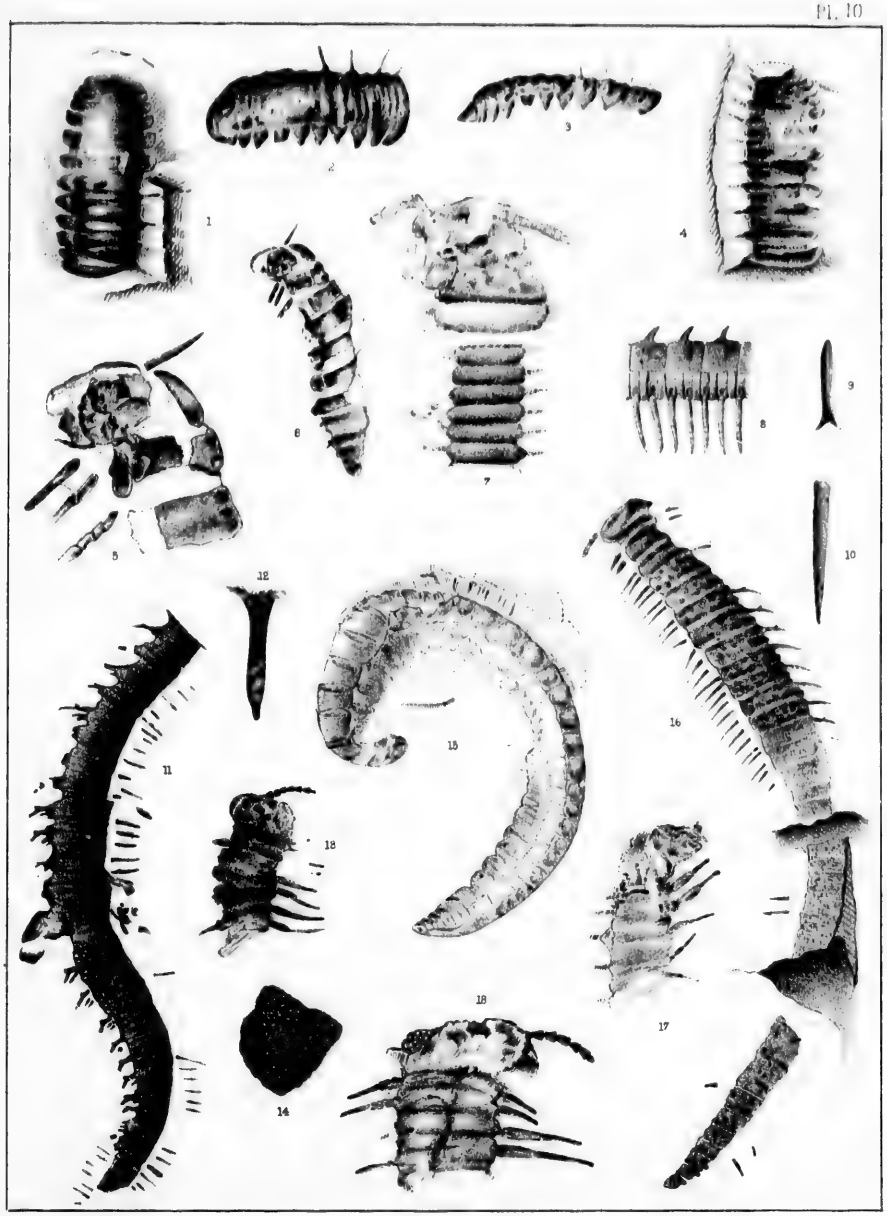
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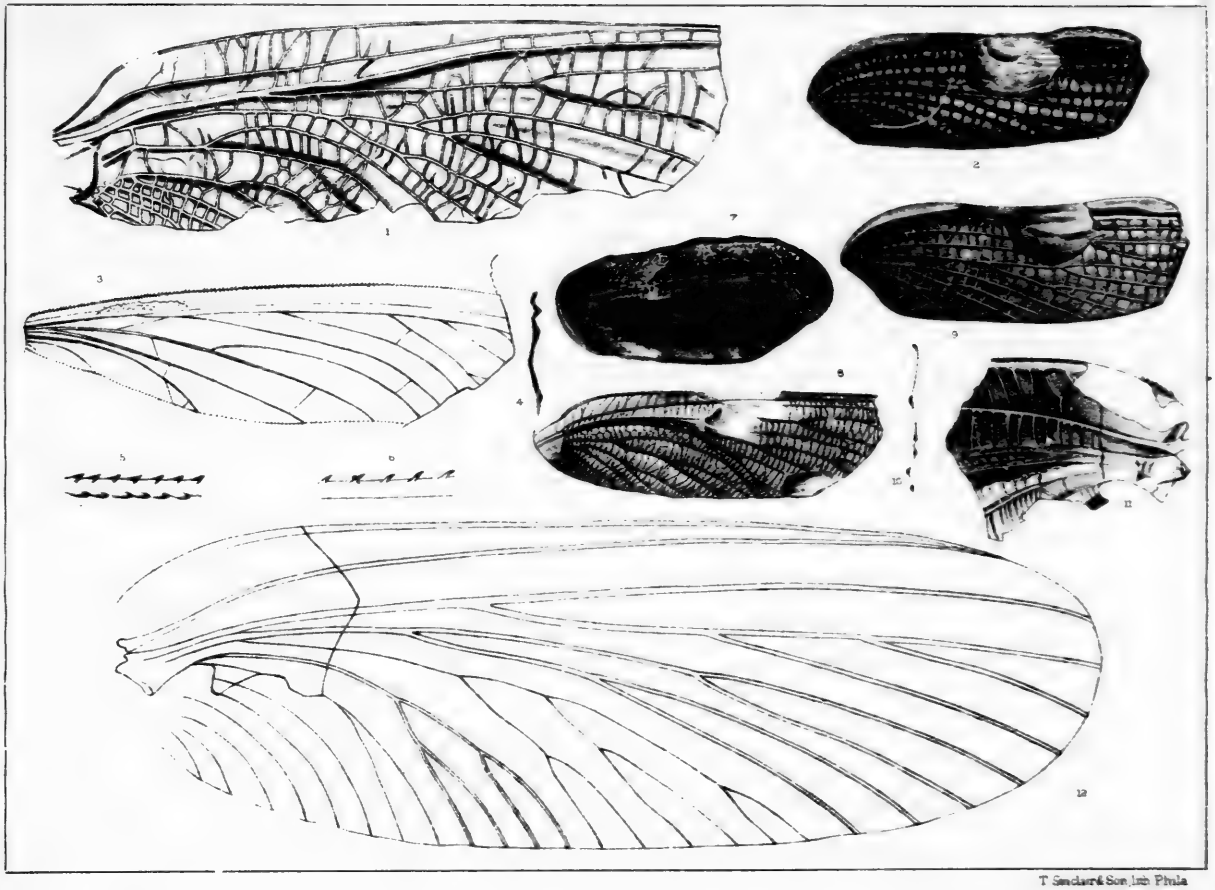

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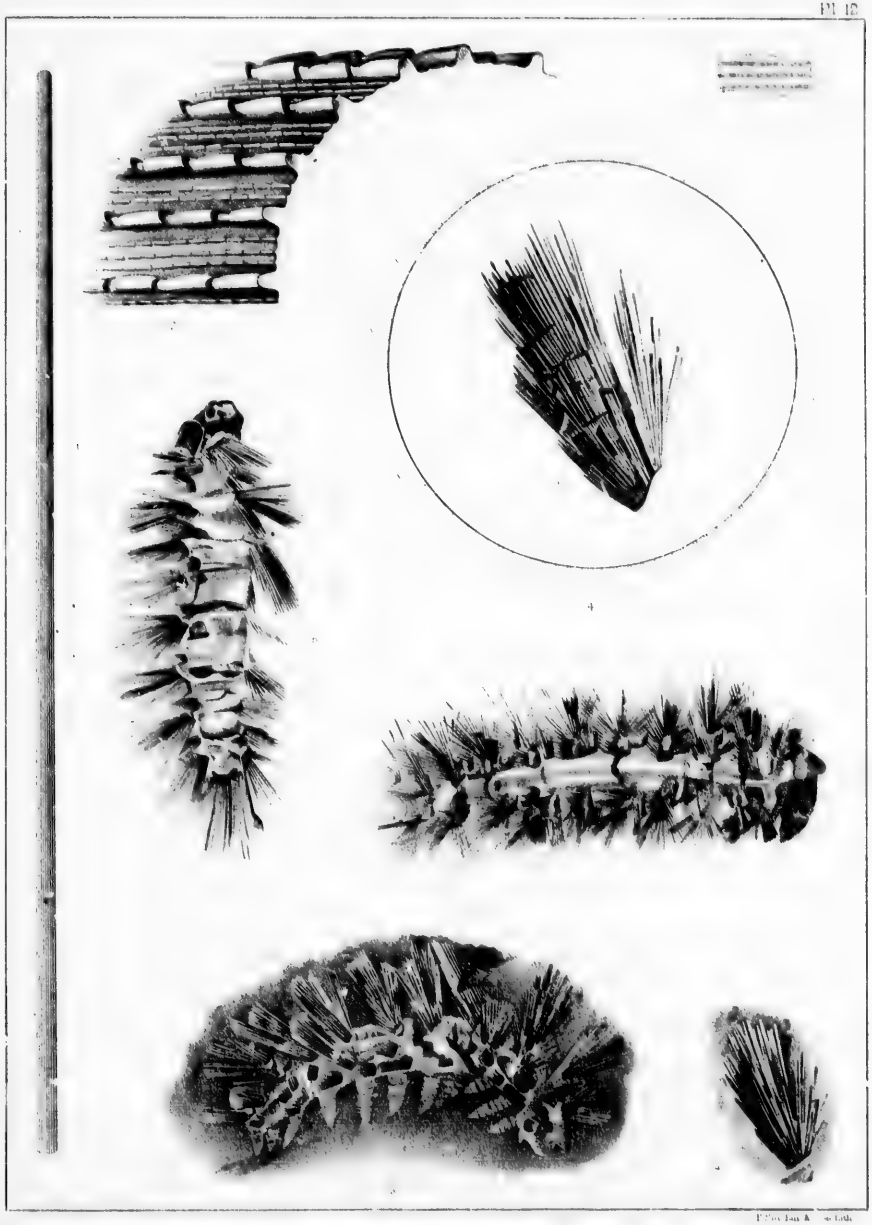

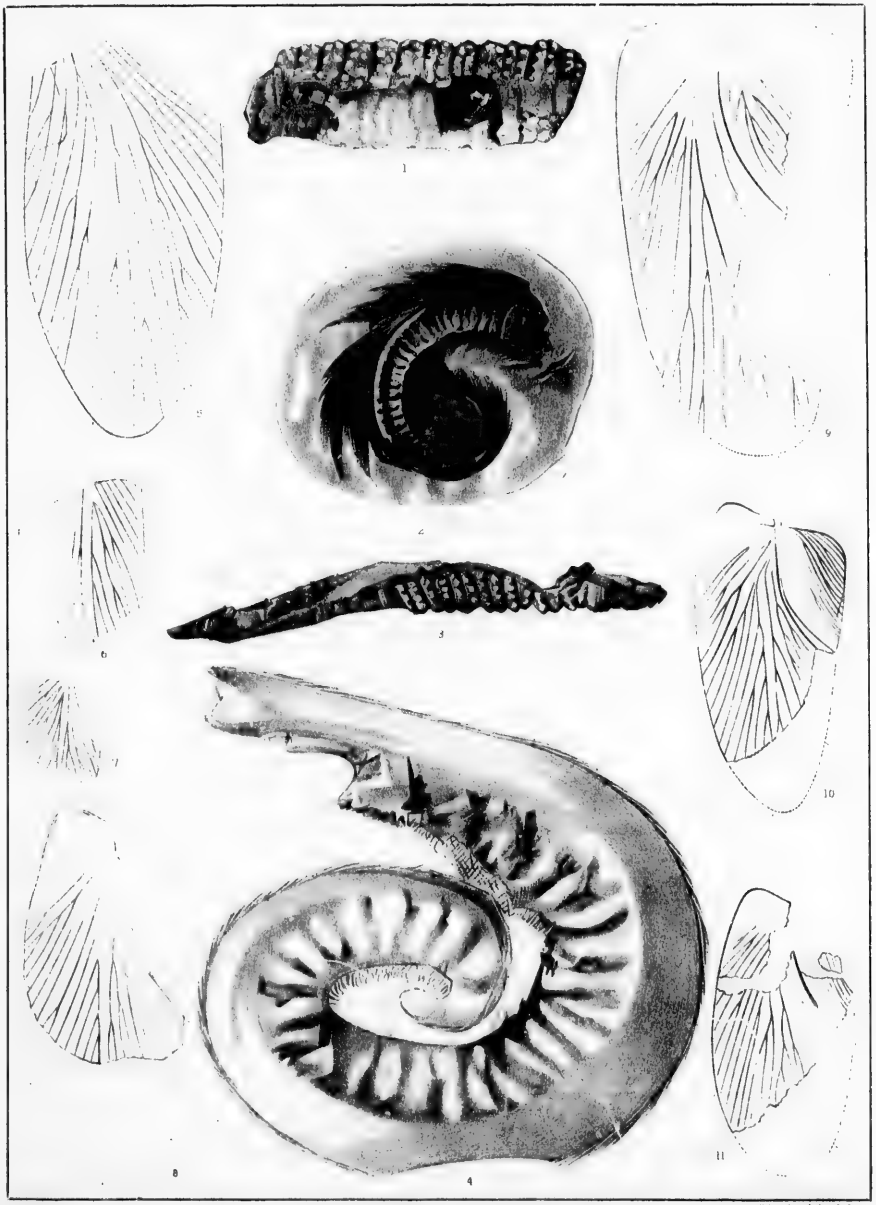

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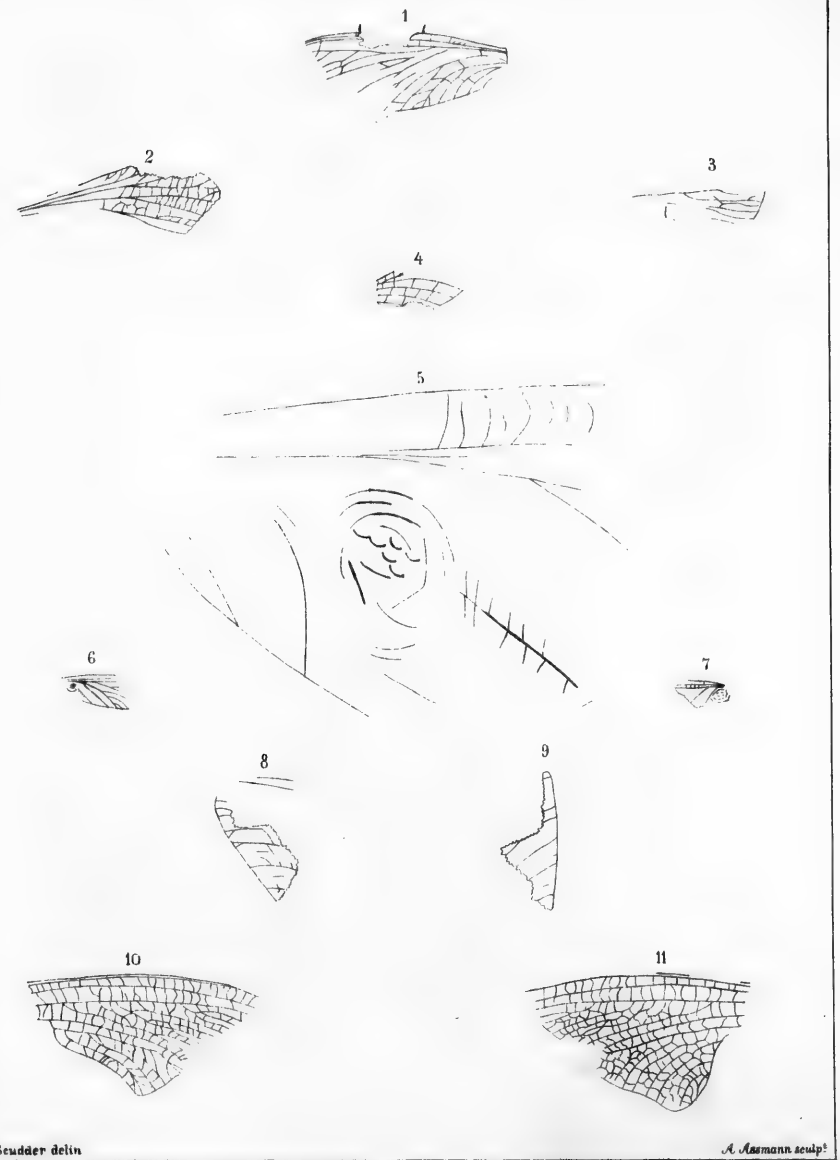

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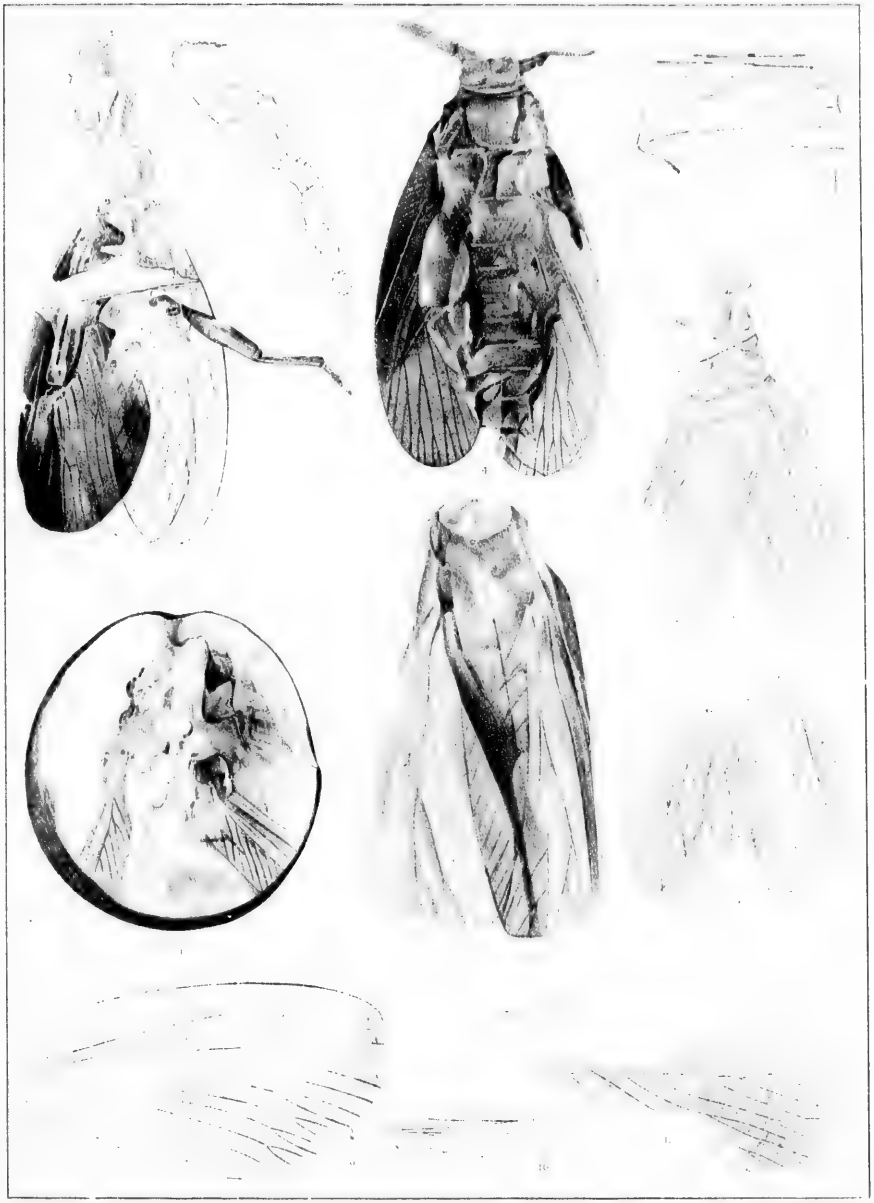

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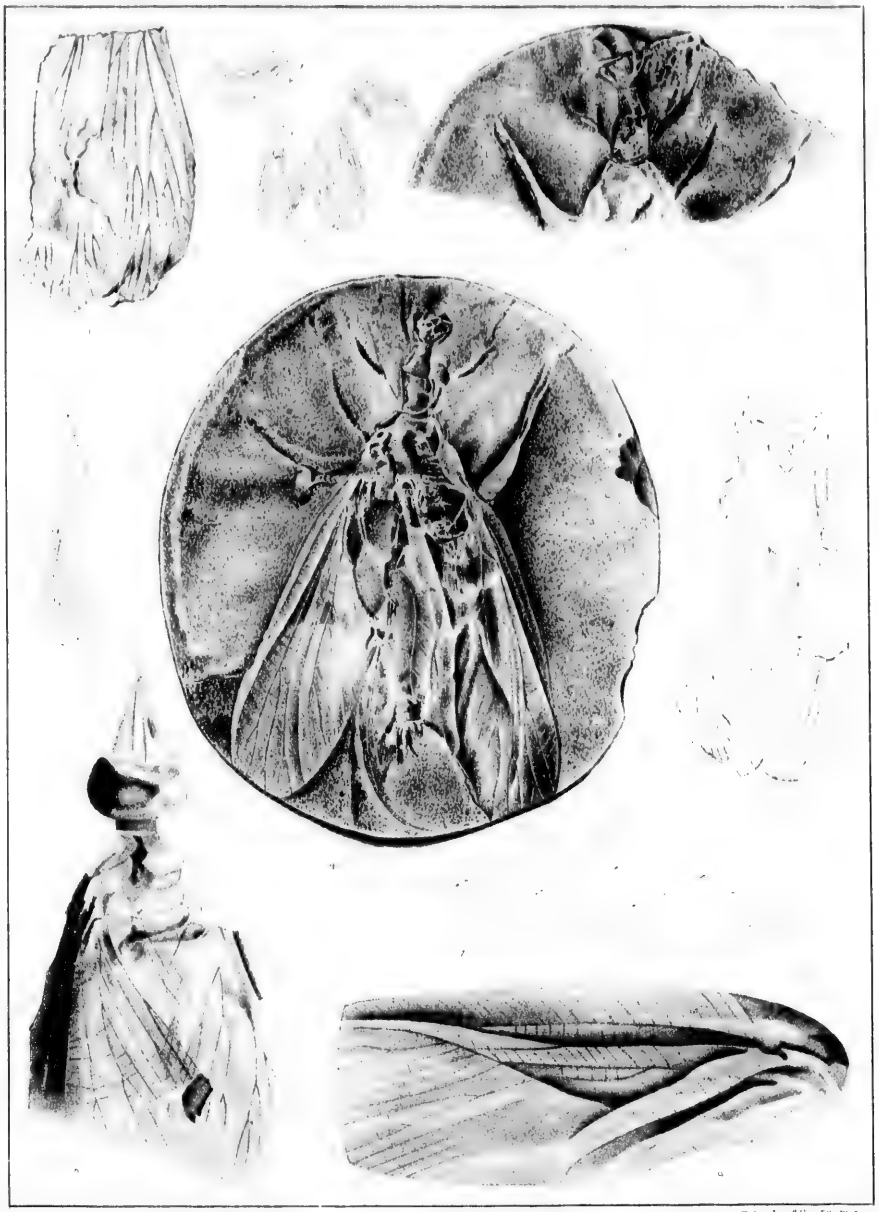

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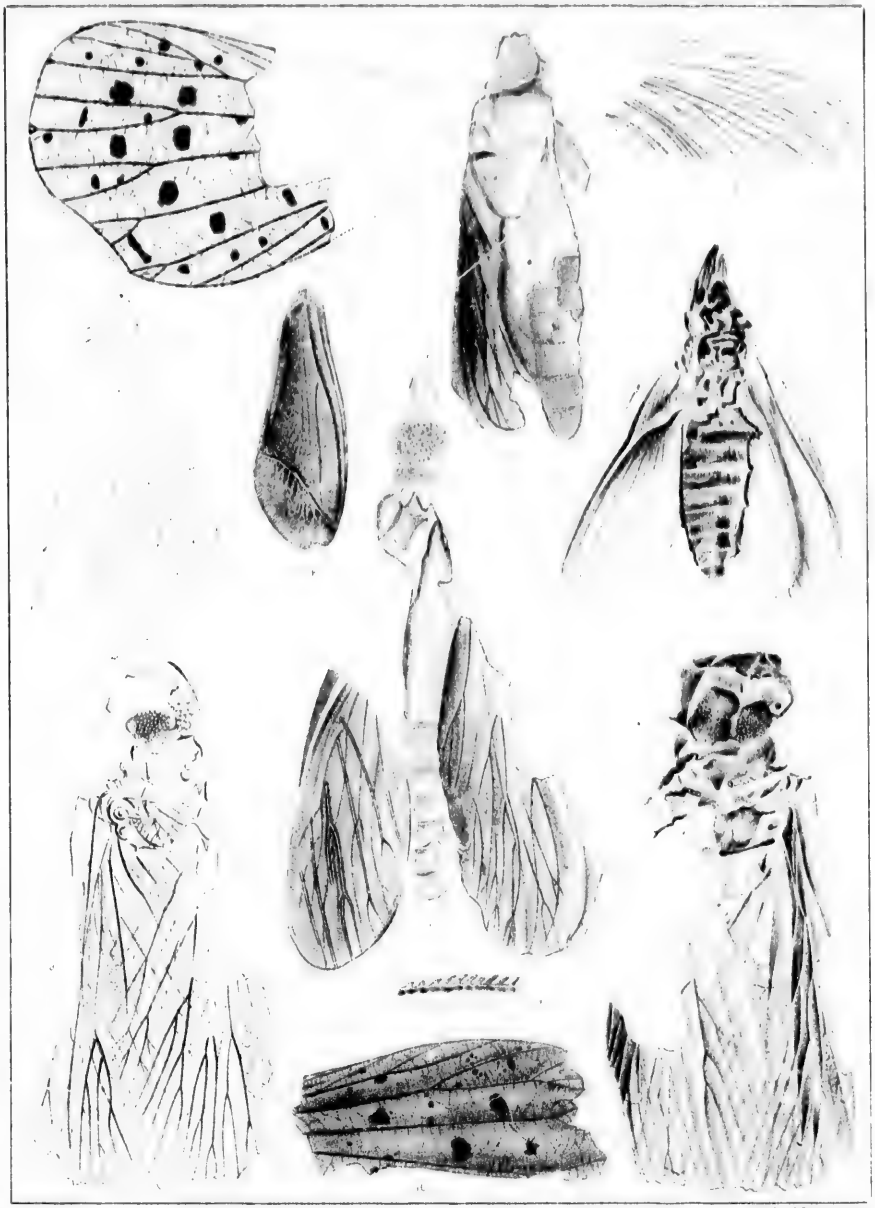

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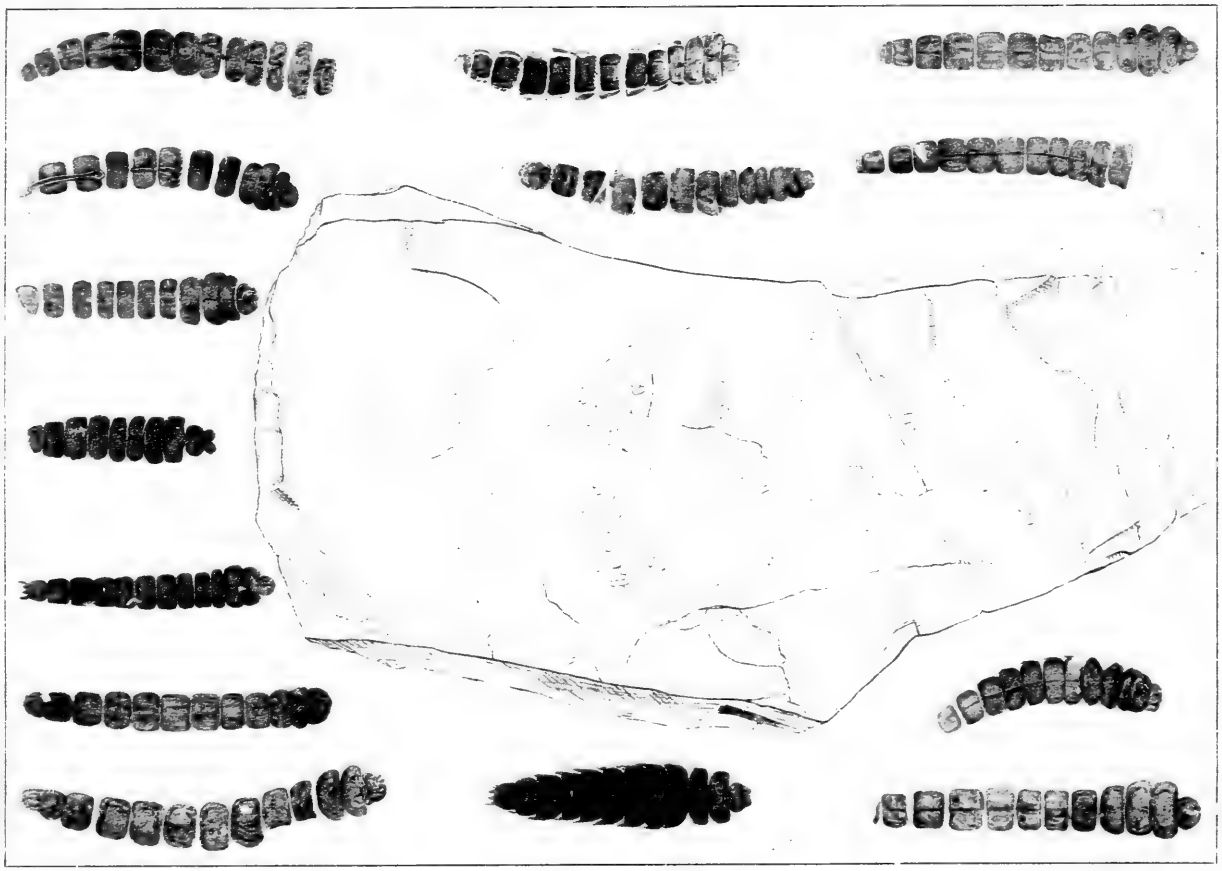

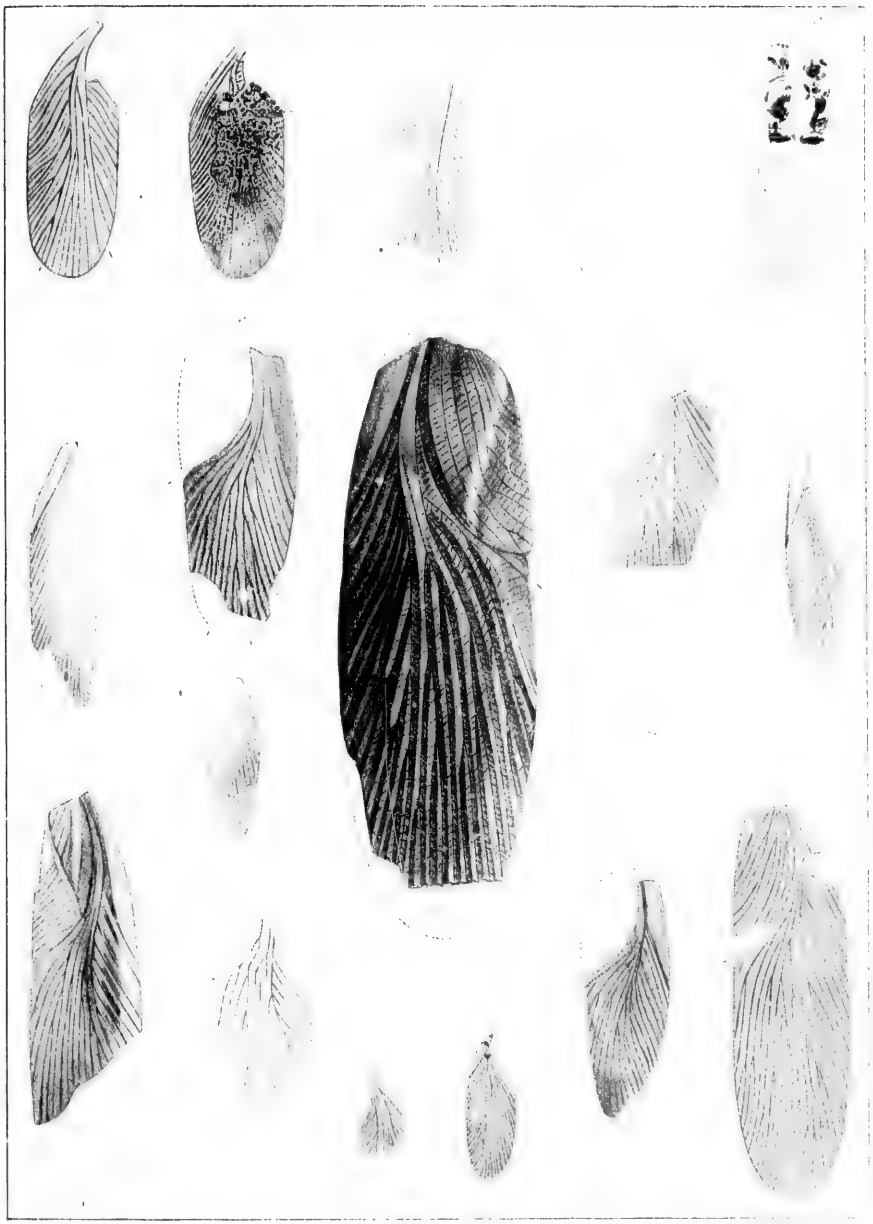

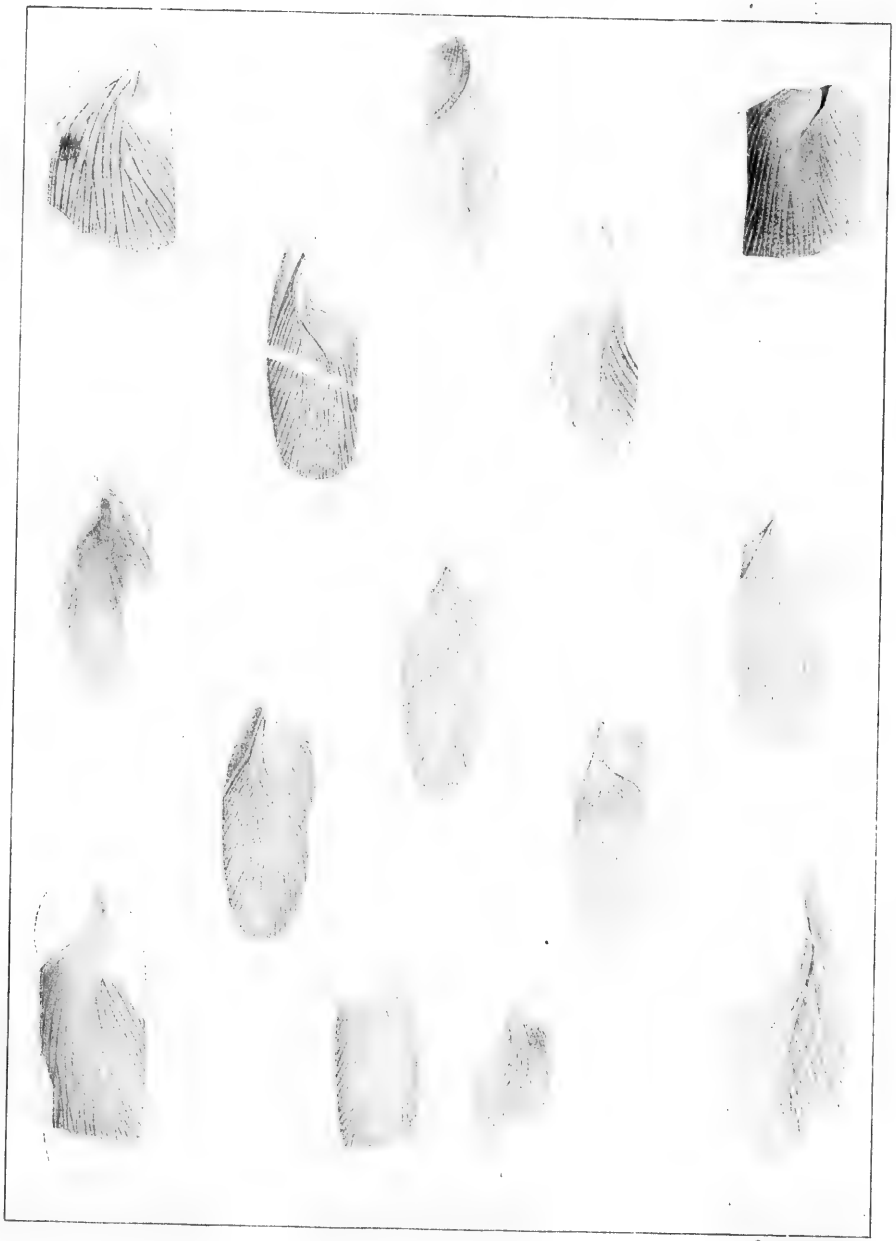

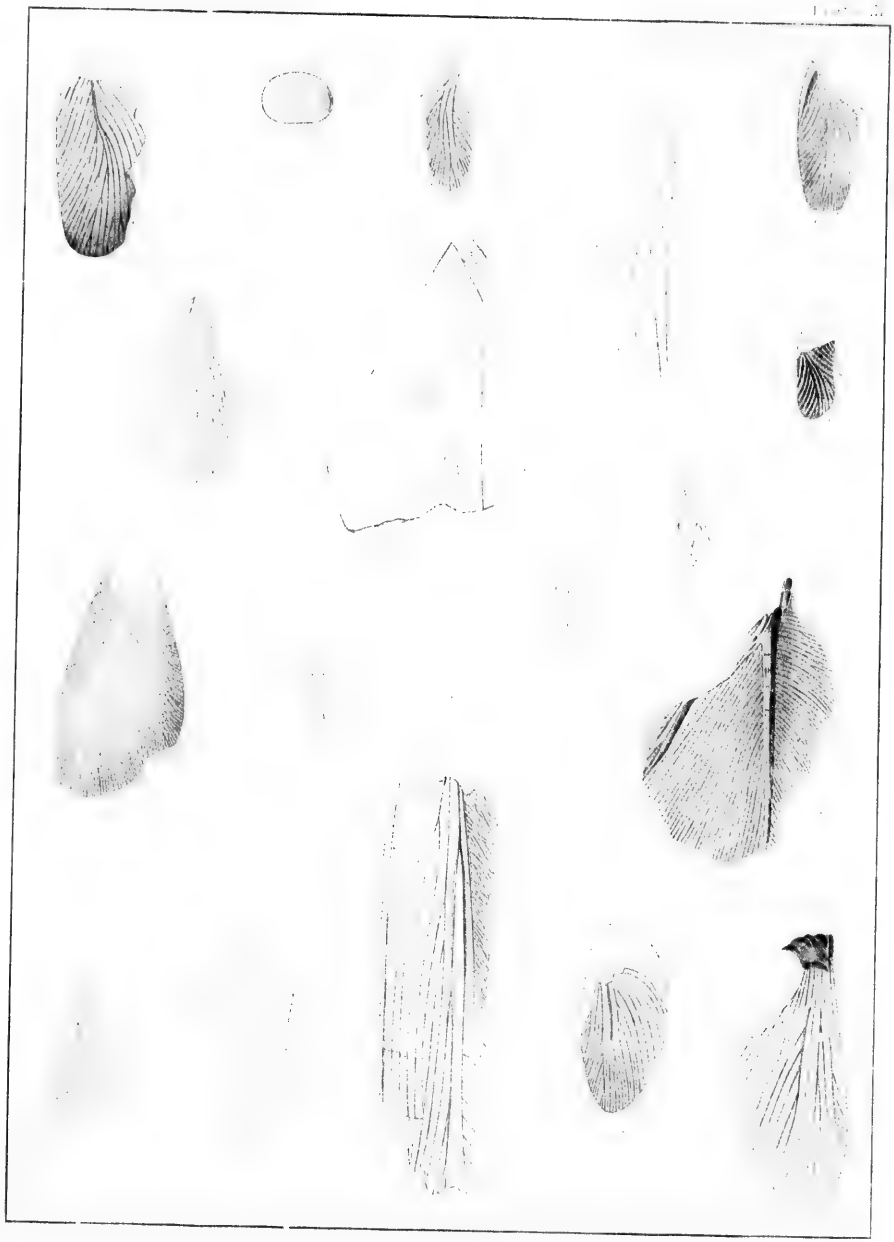

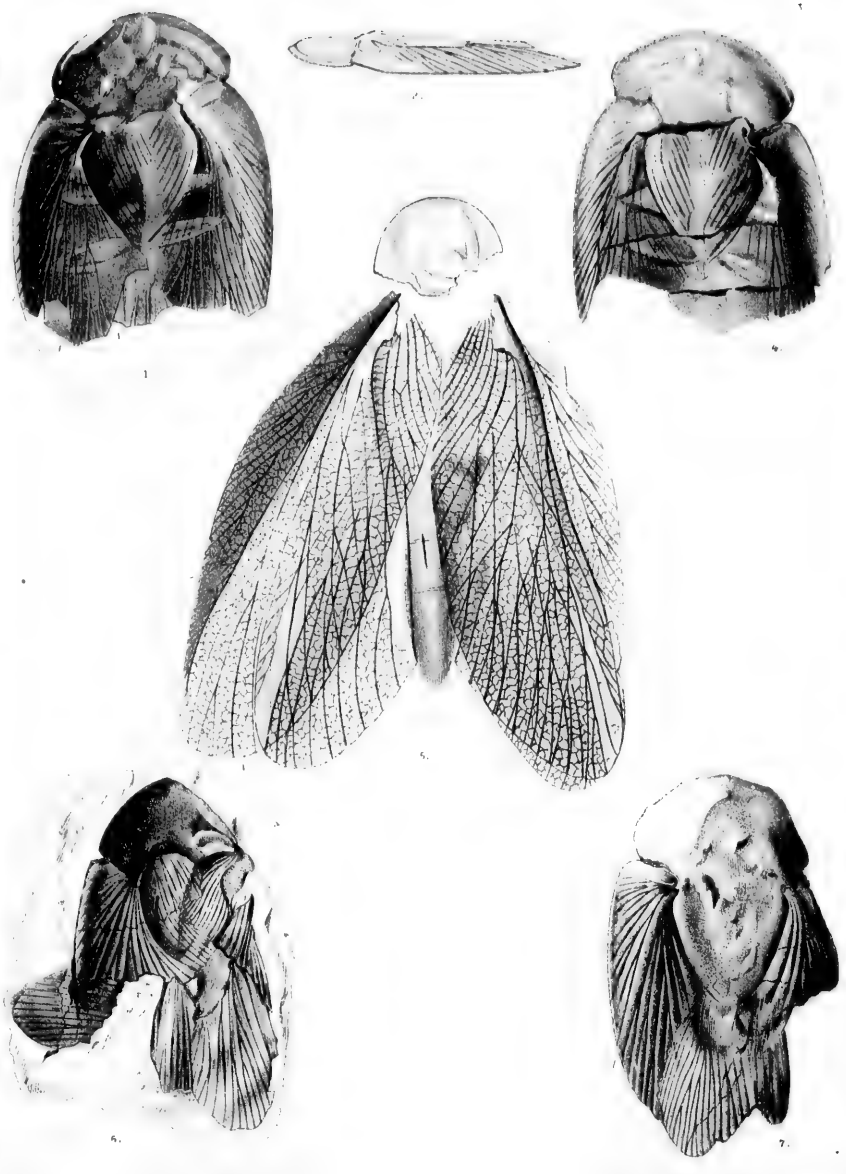

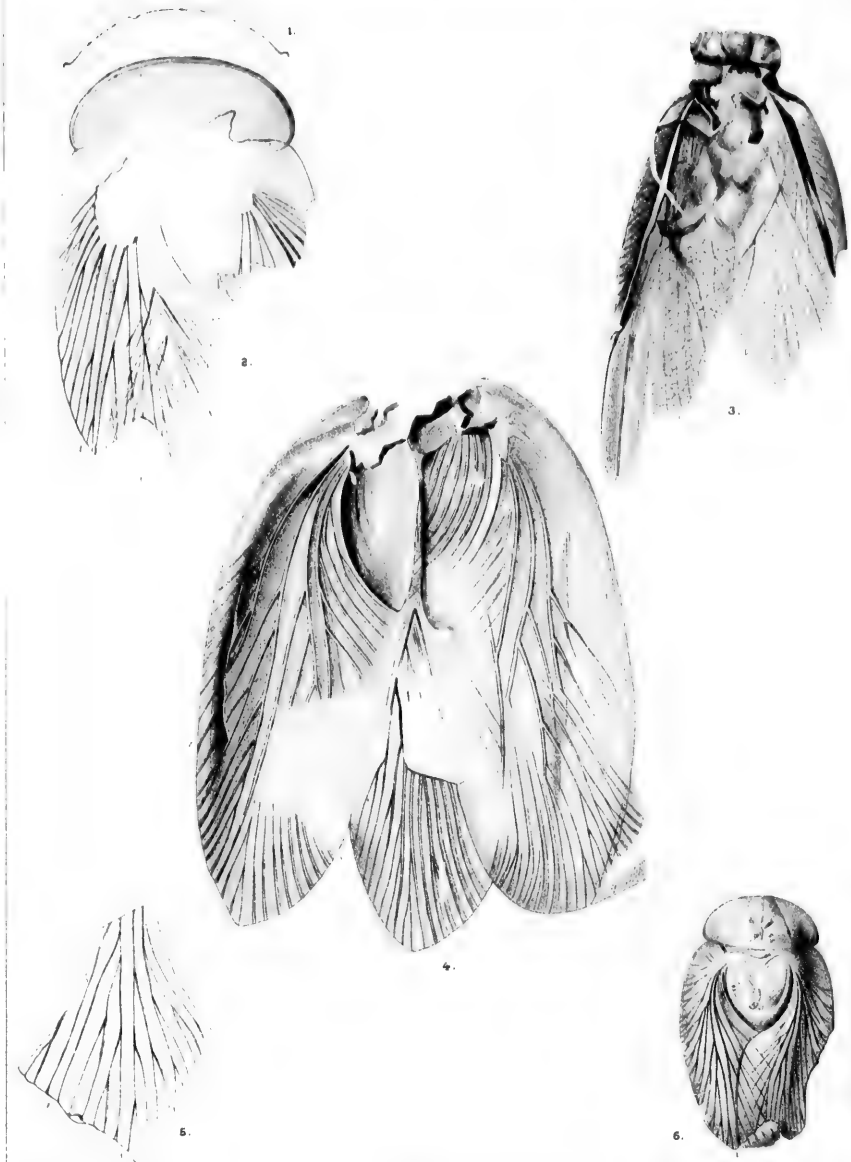
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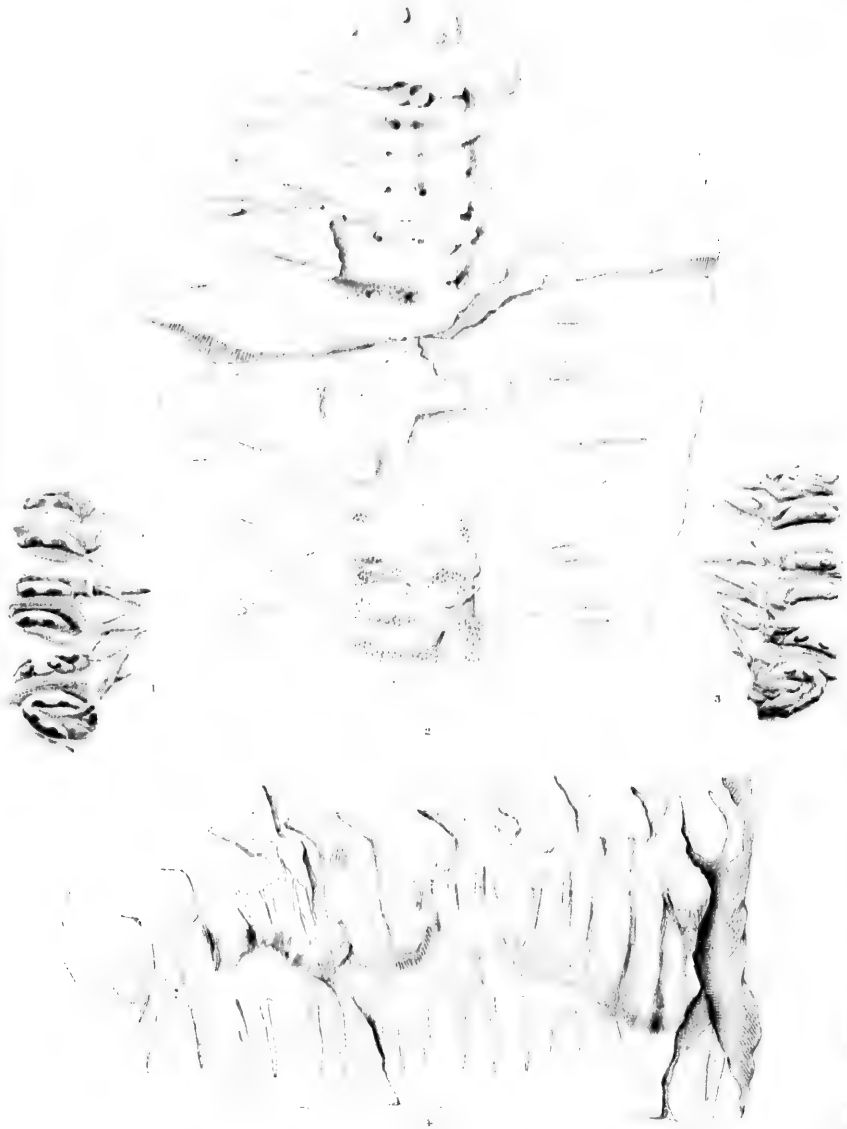

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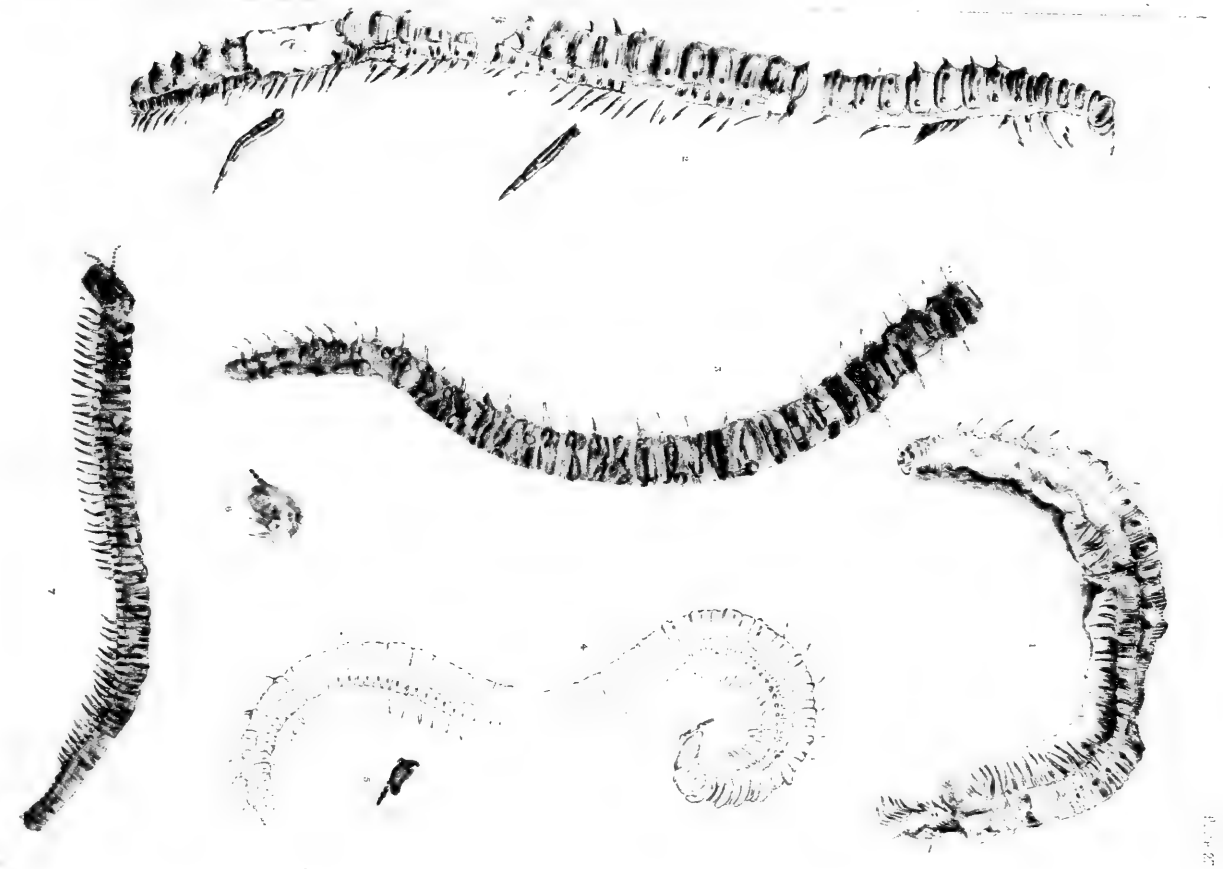

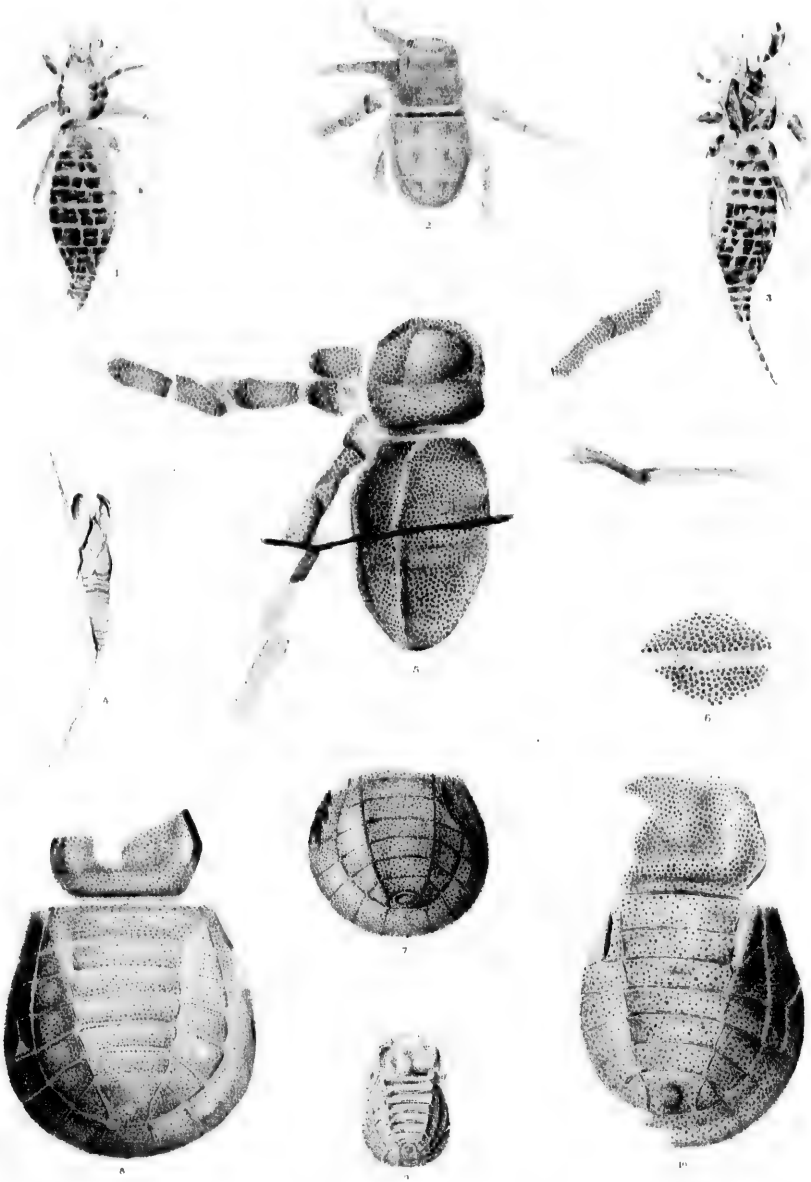

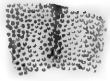

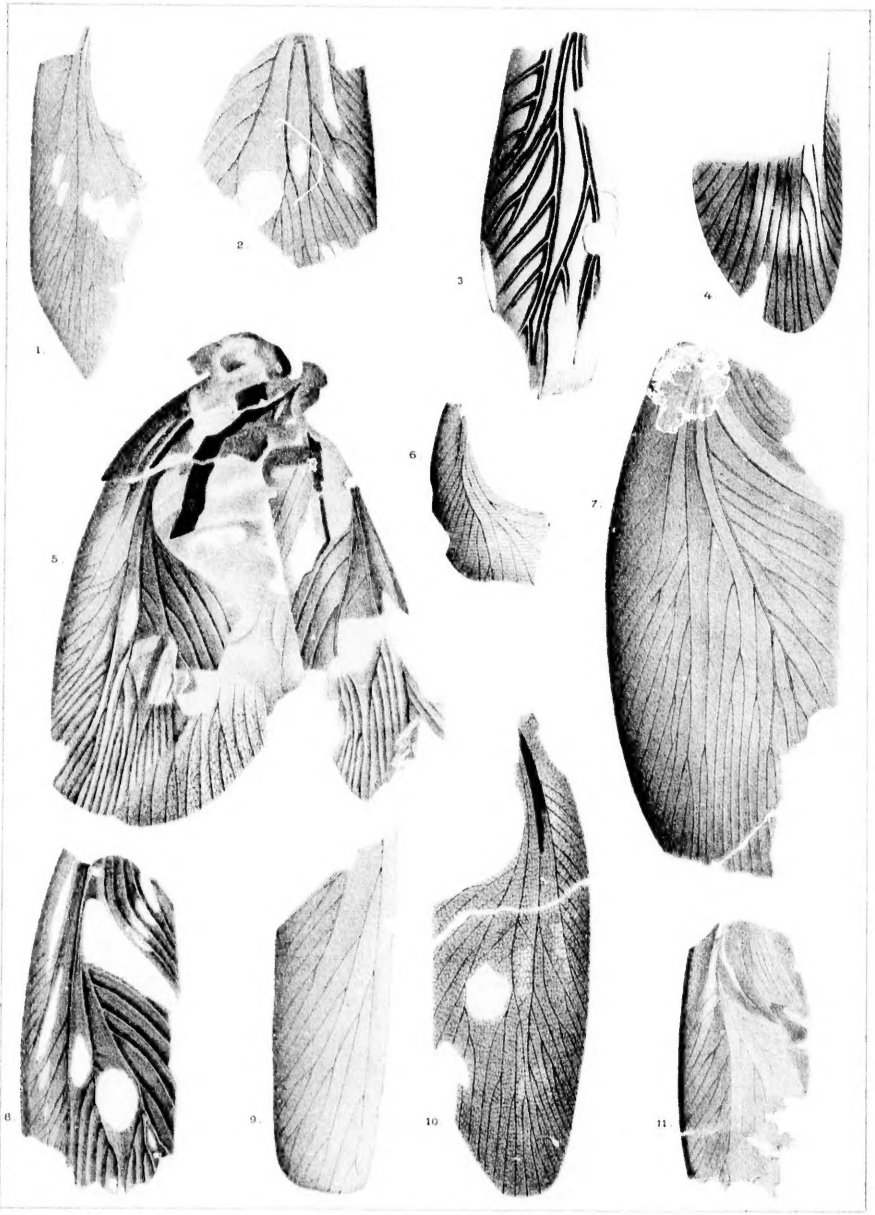

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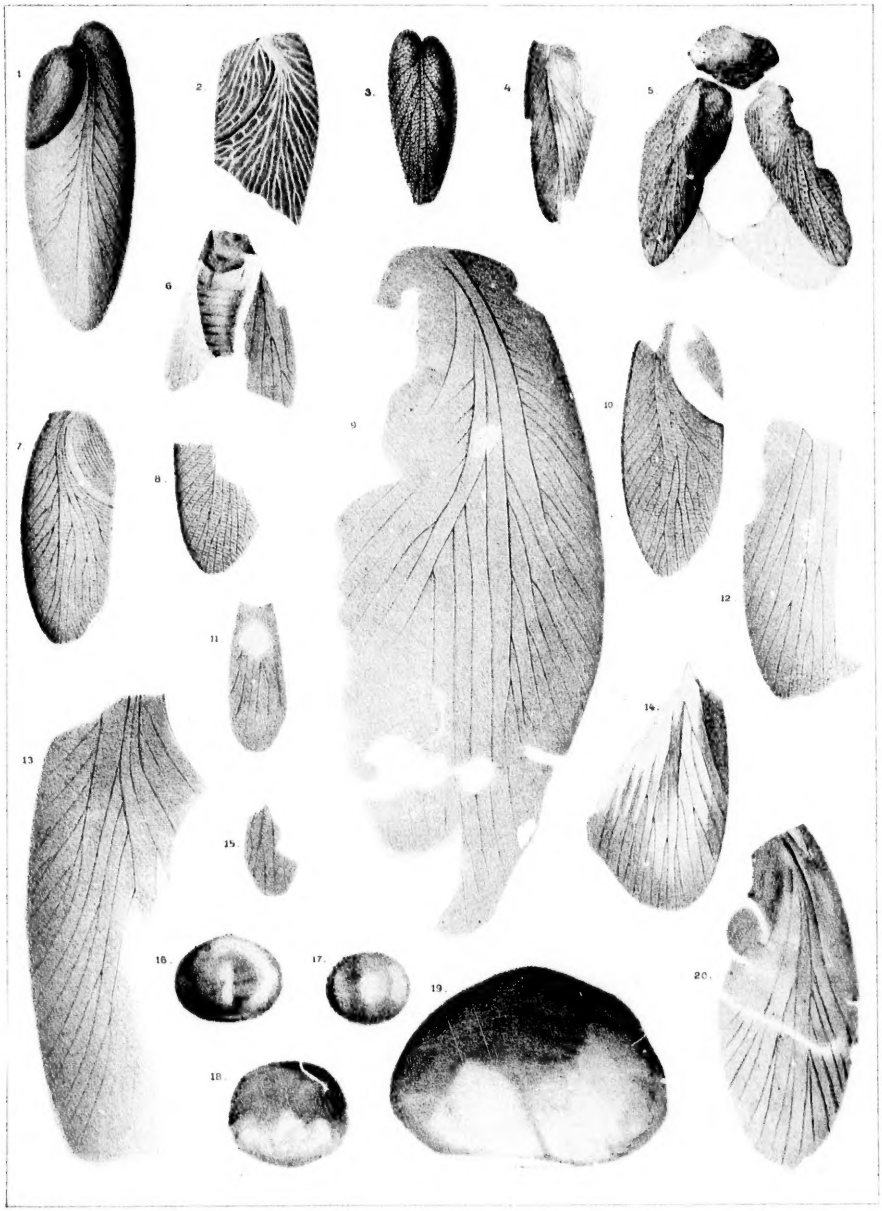
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